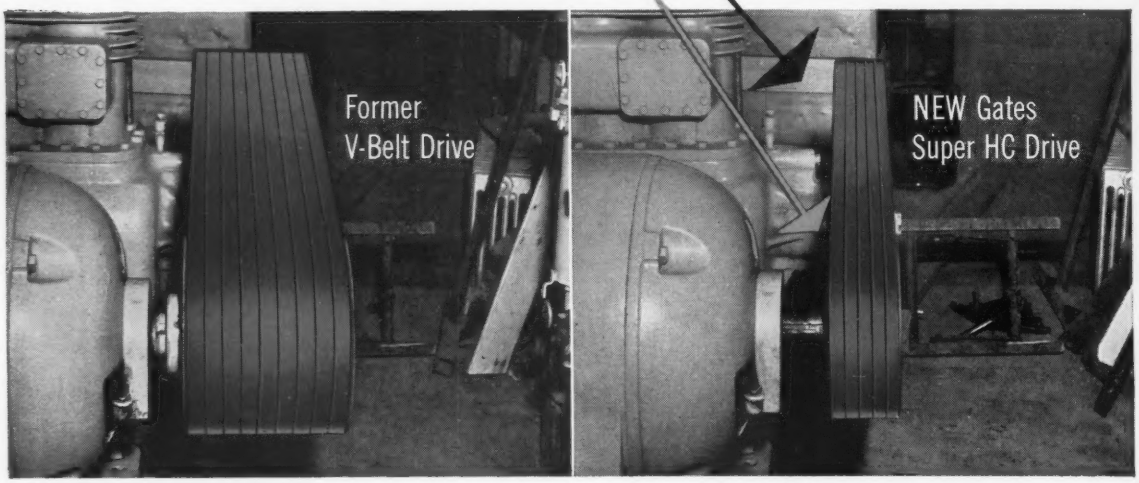
Design Engineering

DOLLARS A YEAR PUBLISHED BY THE MACLEAN-HUNTER PUBLISHING COMPANY LIMITED, TORONTO, CANADA September 1960

mechanical POWER TRANSMISSION

belt applications / Backlash in gears / High speed bearings

Same machine...same horsepower...new compact drive



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We have no wish to offend the wonderful guys in the business, but we'd say that trying to get a cover them: out of the mechanical power field is a bit complicated. Bryan Mills originated this one — it ties in nicely with our lead story on v-belts. Looks somewhat convincing, don't you agree?

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Wherever there's a need to reduce friction, size and weight — there's probably an application for a miniature bearing.

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This modern age of jet and missile calls for very little backlash allowance when selecting precision gears.

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94 Shortcuts to maxima and minima ..... **W. H. Sheppard, B.Sc.**
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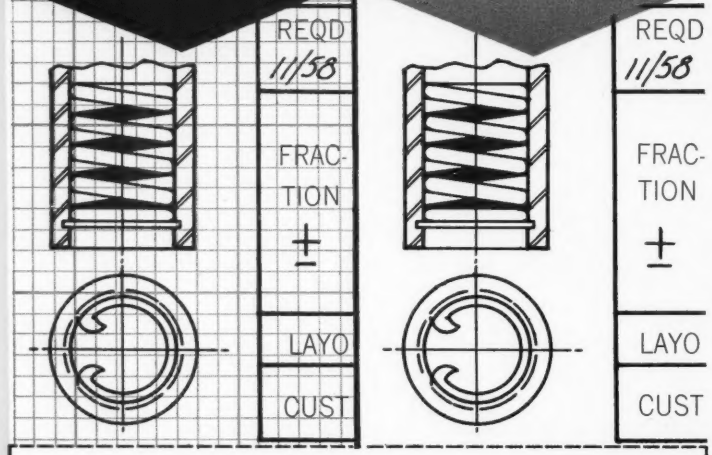

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The contributors

Among them there's a heap of ingenuity in this month's contributors. The things they've done (severally, of course, not together) include inventing a weapon of war, building radio-controlled model aircraft, developing a radically different typewriter, carving replicas of famous firearms, patenting a floor tile which allows curved designs instead of the present squares, dreaming up a new indoor game and heaven knows what else.

In fact, the things this month's contributors have done would fill far more space than we have at our disposal.

The ex-meat cutter who polymerizes

Take George C. Fair, for instance, who wrote New Concept in V-belt Power Transmission. In the course of acquiring an education he held the following jobs: meat cutter, variety store trainee, night club cashier, investigator, store clerk, post office clerk, house manager, maintenance "bull gang," etc.

Having sufficiently demonstrated his ingenuity, he then settled down in the industry which his father had followed. George himself had sworn he would never have any part of it, but after 15 years he now appears to be "polymerized."

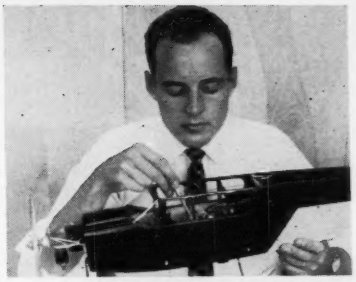
The engineer who hunts (in season)

Jack Beecher, author of the story on miniature bearings, is a member of the product engineering department at Miniature Precision Bearings Inc., where he is responsible for the design and application of standard and special types. But he isn't completely wrapped up in bearings. After working hours he gardens (in season), skis (in season), hunts (in season) and any time of the year carves those replicas we were telling you about and builds the radio-controlled model planes.

The engineer who designed a house

Bob Leeming, who sent us the piece on anti-friction bearings, is equally ingenious in his own way. He designed the house where he and his pretty Scottish wife are raising their three children. And while in Germany on a scholarship five years ago he did some technical translations.

The scholarship came after he was graduated from the University of Toronto in engineering and business. In Germany he studied at the Technische Hochschule in Munich and spent his vacations working for Kugelfischer Georg Schofer & Co., the company that awarded the scholarship. Later he joined the firm and returned to Canada to work for the subsidiary, Fischer Bearings.



Beecher and model plane

Leeming and house

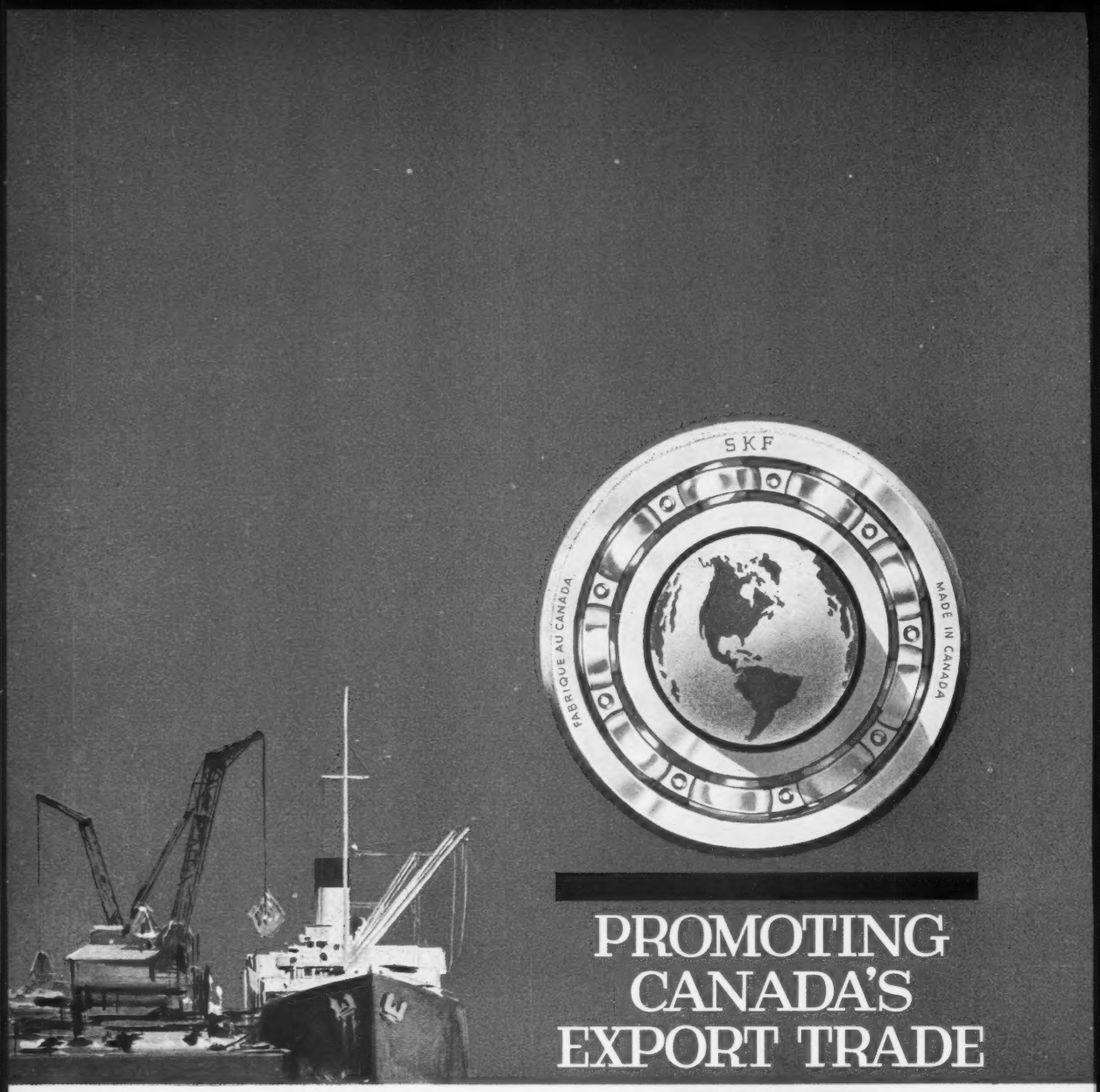
The writer who invents

E. T. Burch, the staffer who contributed the story, Canadian Design in Materials Handling, couples ingenuity with fertility. Though not an engineer, he has engineered more projects than most of us produce in a lifetime.

For instance, he has a "fairly workable idea" for a typewriter which discards fundamental mechanical linkages in favor of an electrical method of applying type to paper. There's still a great deal of engineering design and development to be done and Ted hopes to find the man with the necessary capability (which he lacks).

He has applied for a patent on a floor tile which allows curved designs instead of the more formal squares and rectangles. He has developed an indoor game for two players (adults or children) which he is thinking of patenting. He has devised a variation of lacrosse which just might cause a revival of this ancient game developed by Canadian Indians.

And if that isn't enough ingenuity for you, during the war, as an officer of the Queen's Own Cameron Highlanders, he developed a light machine gun to replace the Sten. He got as far as rough sketches, but lacking facilities for engineering design and development, he had to abandon the idea.



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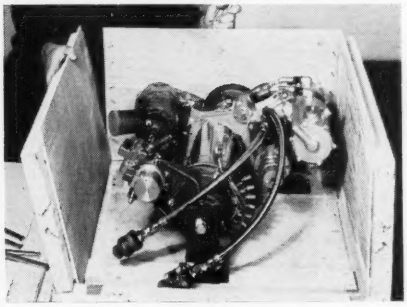
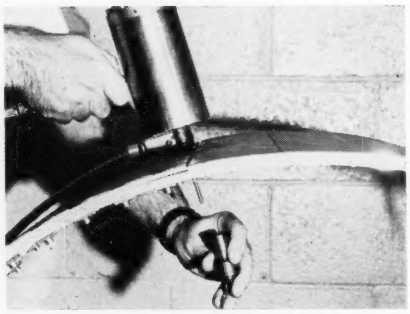
Reports — A world roundup of engineering and design interest

Multi-purpose box eliminates seven handling steps



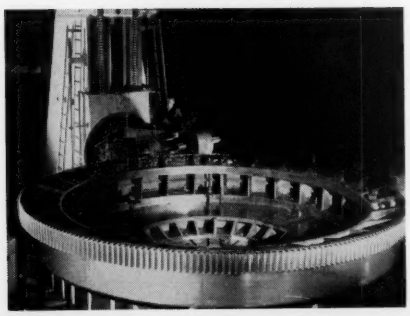
This is an auxiliary power unit, but the unit is only incidental to the story. It's the container we're concerned with, a versatile multi-purpose box designed by Boeing. The container eliminates a seven-step procedure for handling these power units. Before it was designed, the units were shipped to Boeing in a nailed box. The seven steps included removal for inspection, repacking in in-plant containers, unpacking and mounting for functional tests, and re-packing in in-plant boxes for storage or for movement to assembly areas. The container replaces the shipping box, the in-plant handling box and a test stand. Total saving in packaging and handling costs: 50 percent. Now the units are removed only once — for installation. Diagonal spindles lock the box into a rigid shipping, handling and storage unit. Top and sides are easily removable, as shown.

No-yoke dimpler operates in areas once inaccessible



A new lightweight, two-stage portable dimpling tool has been developed for areas formerly inaccessible to ram-coined dimpling equipment. Hydraulically operated, it weighs only six pounds and can be operated with heated dies. Instead of a conventional C-yoke, it utilizes a high strength tool steel mandrel with dependable yield strength in excess of 230,000 psi to withstand forming pressures in the range of several tons. A clamping assembly is slipped onto the mandrel from the inside of the material to be dimpled. The design of the mandrel facilitates rapid replacement when changing to various dimple diameters. The dimpler was developed by Boeing, where it eliminates the necessity for removing the airframe skins to perform dimpling operations formerly inaccessible with portable C-yoke dimplers.

Giant hobbing machine produces 32 ft. gears



Gears up to 32 feet in diameter, 10 feet in face and weighing 70 tons are possible with a new hobbing machine, the largest in Britain and possibly in the world. The machine was built by David Brown Ltd. especially to facilitate the production of 24 huge gears comprising eight sets of combined gear and path rings ranging from 21 ft 2 in. to 23 ft 11½ in. in diameter and weighing between 25 and 28 tons each. The gears when completed will be used as major driving gears in a sugar refinery. The hobs (the machines which do the actual cutting) measure approximately 16 in. in diameter by 18 in. in width. An indication of the size of the cutting operation is that 15½ tons of metal were removed from the eight sets of gears.

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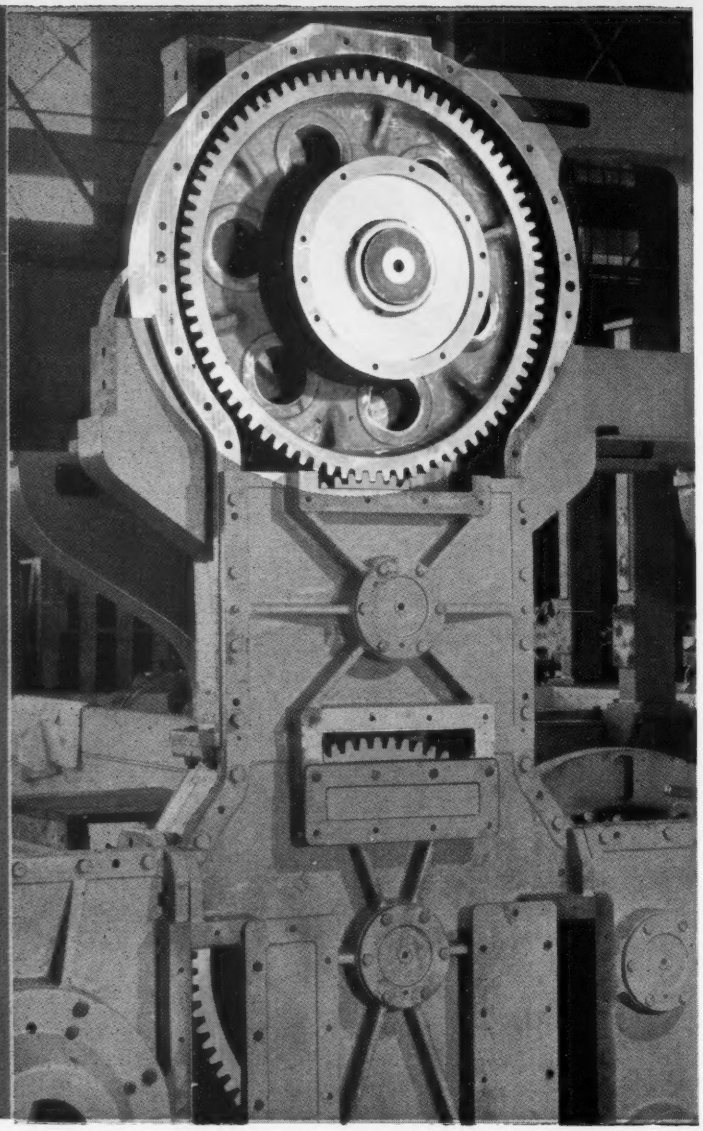

Built for Black-Clawson (Canada), Limited, these huge gears, for high speed paper production, were cast to give completely dependable, trouble-free operation. Once again, Canada Iron's technological facilities and large casting equipment were equal to the job.

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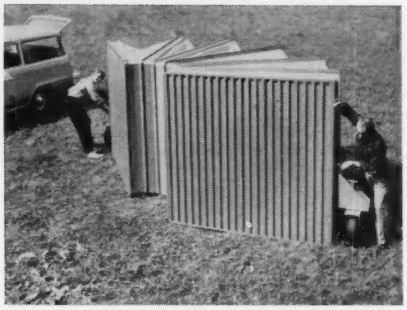
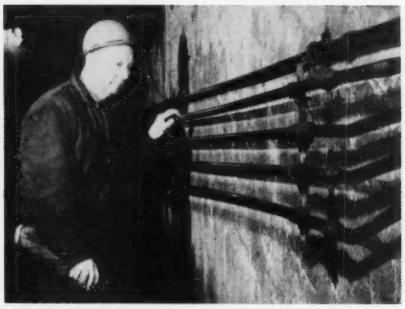
Box-on-wheels expands into mobile shelter



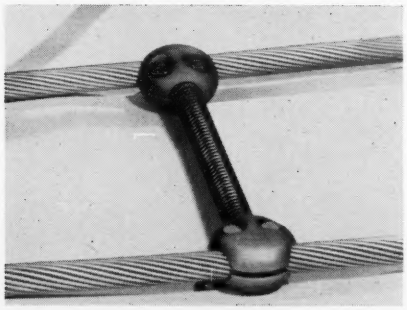
Park the car, unhitch the box trailing behind, spread it out like a fan and what have you got? Instant house! The trailer that concertinas into a shelter was unsqueezed at the 1960 International Mobile Home Show; it's the latest design commissioned by the Aluminum Co. of America in a continuing program to find new ideas for aluminum. The trailer, known as the Forecast Accordian, operates like the familiar squeeze-box. Squeezed together, it's a compact unit of less than 200 cub. ft. which rides jauntily down the highway. Opened up, it expands to 700 cu. ft. to provide six pie-shaped compartments, which can be made completely private with partitions. Outside there are two porch areas, each under a canopy; one has storage compartments for supplies, the other is equipped with fold-down table and benches for mealtime.

Plastic coverings reduce pipe corrosion



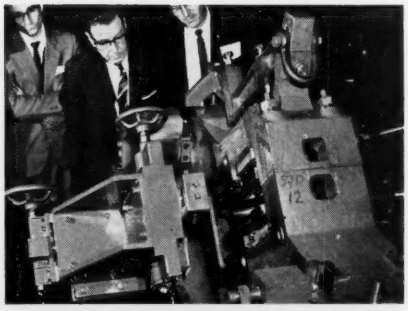
Here's a solution to corrosion problems in coke oven areas. When the standard galvanized conduit needs replacing (as it will sooner or later), install lightweight steel tubing with a plastic coating. Republic Steel came up with this solution to a severe corrosion problem in its own mills. A plastic-coated tubing was installed 18 months ago to combat highly corrosive conditions resulting from coke quenching. The raceway is still in the same condition (see cut). Plant engineers estimate that on this performance the plastic-coated tubing can be expected to hold up for many years to come. On the other hand, the galvanized conduit it replaces was badly corroded in five years, and the steel housing of motors and cast-iron terminal boxes was completely eaten away. The new coated tubing comes in sizes from ½ in. to 2 in.

Transmission line spacer offers strength, flexibility



This is a spacer for bundled transmission conductors. Its design provides column strength to resist short circuit forces, plus great flexibility in other directions to permit normal conductor movement. The spacer incorporates a stainless steel spring separating cast aluminum clamps. A variant design, produced to satisfy the utility industry's interest in three-conductor bundles, is a "tri-spacer" using the same type of helical spring component with spherical clamps. Both types are designed to hold in proper physical relationship the two or more conductors in an electrical transmission line bundle. The spacer, known as a hamburger bun because of the appearance of the oval clamps at the end of the helical spring body, is a product of Alcoa research. It is currently being installed by the New York State Power Authority on part of a tie-line connecting the St. Lawrence and Niagara River projects.

Don't remove the rolls from the grooving machine



These steelmen are studying a roll grooving machine designed to utilize the housing unit feature of a new type of stretch reducing tube mill. As shown in the photo, the housing unit fits into the grooving machine on the same surfaces as it fits into the mill and the milling head is permanently fixed at the pass line. Otherwise the rolls would have to be removed from the mill, mounted on an arbor and machined to a template in a tracer lathe. Incidentally, the stretch reducing mill can reduce 7 in. tubing to sizes ranging from 1½ in. standard tubing to 5 in. line pipe or casting. Its capacity is 800 feet per minute or 35 tons an hour. The mill was developed in Pittsburgh and shipped to Mexico for integration into a $5 million expansion and modernization program.

THESE SURFACE TRACES PROVE

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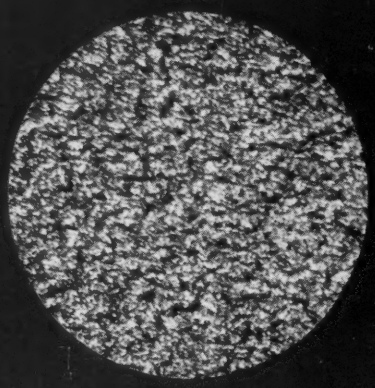
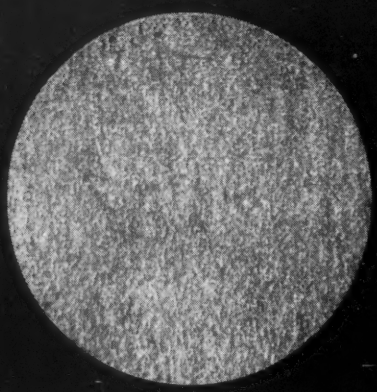
STANDARD DRAWING BRASS
(grain size, .045 mm) — after 40% elongation



ENLARGED SURFACE TRACE showing the roughness that causes "orange peel" effect in the working of standard drawing brass. Smoothing such mountains down to the valleys takes a lot of cutting—cost of polishing compounds runs high—production is low—bottlenecks hamstring operations.

THE SURFACE of the stretched standard drawing brass sample looks like this when seen in oblique illumination and magnified 20x. For small deep-drawn products, it might take up to five polishing wheels to finish a surface with roughness of this order—even at low machine speeds.

FORMBRITE DRAWING BRASS
(grain size, .005 mm) — after 40% elongation



ENLARGED SURFACE TRACE showing Formbrite's smoothness even after deformation, the test of polishing characteristics of a drawing brass. Little hills like these are easy to level. The trace explains why polishing savings reported by Formbrite users are usually 40% to 50%.

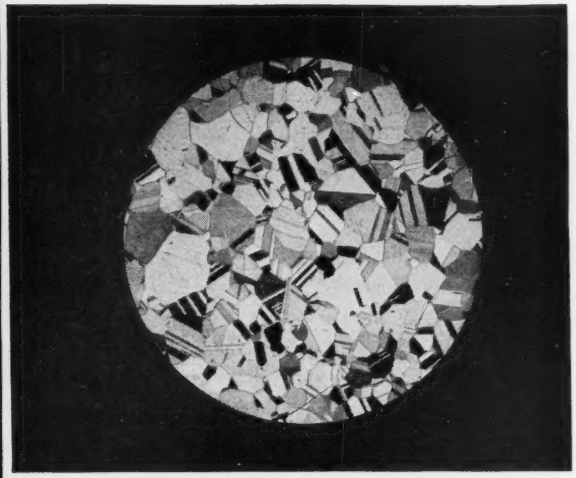
WHEN SEEN IN OBLIQUE ILLUMINATION and magnified 20x under the microscope, the stretched Formbrite surface looks like this. Even in such deep-drawn products as pen caps, only a light cut and a color buff are needed for a jewelers' finish—often a color buff alone does the job.

DESPITE its superiority, Formbrite costs no more than standard drawing brass. It is produced in the following brass alloys: Yellow Brass, Cartridge Brass, Gilding, Commercial Bronze, Red Brass, and Low Brass. The Formbrite process is also applied to brass wire alloys for cold-heading and upsetting purposes—for a stronger, springier, more abrasion-resistant product.

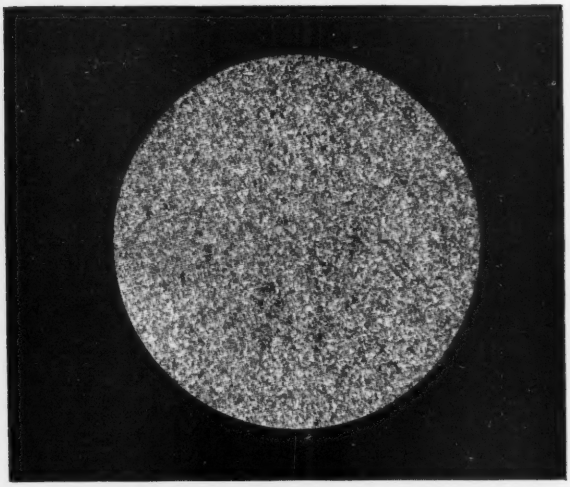
For further information, write for Publication B-39, "FORMBRITE", to Anaconda American Brass Limited, New Toronto, Toronto 14, Ont. Sales Offices: Quebec City, Montreal, Calgary and Vancouver. C-6052

YOU CAN CUT POLISHING COSTS

grain drawing brass



THIS IS THE MICROSTRUCTURE of the standard drawing brass sample at 75x magnification. The coarse grain structure is typical of the drawing brass that has for decades been used for stamped or drawn brass products. It is the basic reason that polishing costs have run high.



THIS IS THE MICROSTRUCTURE of the Formbrite sample, magnified 75x. The uniform, superfine-grain structure, produced by special procedures of rolling and annealing, explains the relatively smooth surface trace of the stretched Formbrite sample, at the left.

FORMBRITE®

Superfine-grain drawing brass

A PRODUCT OF

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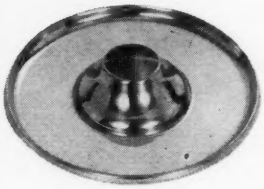
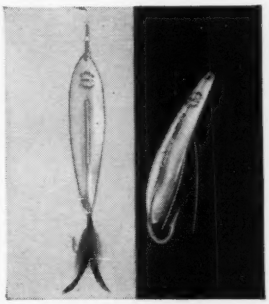
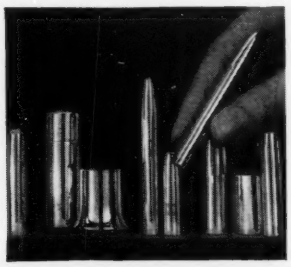
The outstanding feature of Formbrite is easy polishing. But there's something else you should know about it. Formbrite is stronger, harder, springier, and more scratch resistant than the usual drawing brasses. Yet it retains remarkable ductility for forming, stamping, drawing, and embossing. In many instances, these qualities have made it possible to use thinner gage metal.



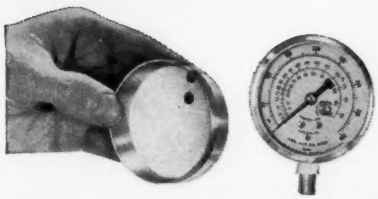
The maker of this tray, after switching from ordinary drawing brass to Formbrite, found he had achieved a cost reduction of 25% in the cutting operation and 42% in the finish buff—and a healthy boost in production rates.

These fishing lures, first made from ordinary yellow brass, are polished for plating by tumbling. After the switch to Formbrite, manufacturer found he had cut his polishing costs 40%. Small-size formed, drawn, or upset parts made of Formbrite often can be satisfactorily finished by the relatively low cost conventional tumbling methods.





A jewelers' finish on these deep-drawn products meant the use of five polishing heads, with regular drawing brass. With Formbrite, manufacturer uses two polishing heads for a light cut, another for a simple color buff, and runs machines faster. Savings run up to 40%.

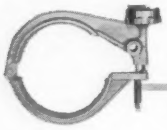


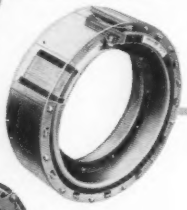
When this gage case was made of Formbrite, the instrument manufacturer found he could drop the cutting operation and get a "mirror finish" with a light buff. The saving in finishing cost was 40%.

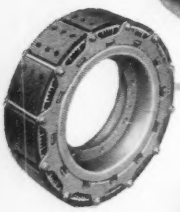
For further information mark No. 103 on Readers' Service Card

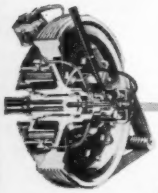
FAWICK... for the best in power transmission components

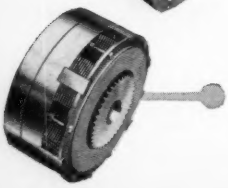
In the complete FAWICK line you will find a type and size that will fit your requirements for design and high operating performance.









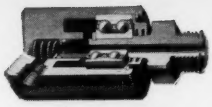


TYPE	SIZE (Friction surface diameter)	TORQUE RATINGS (in. lbs.) (at 75 psi. 100 RPM)	H.P.
CB Clutch & Brake	6″ to 84″	2,040 to 1,130,000	3 to 1750
CS Brake	4″ to 24″	2,000 to 24,000 plus self energizing	
VC Narrow	11″ to 42″	27,000 to 380,000	43 to 603
Ventorque Clutch & Brake Wide	24″ to 46″	219,000 to 900,000	348 to 1430
E Air Ring Clutch & Brake	12″ to 40″	11,300 to 225,000	18 to 357
VE Air Ring Clutch & Brake	19″ to 27″	25,500 to 58,500	40 to 93
EB Clutch & Brake	6″ to 24″	910 to 45,000	1.5 to 71
ER Couplings	6″ to 24″	1540 to 83,500	2.5 to 133
CT Brake	12″ to 24″	15,000 to 65,000 plus self energizing	
FSPA (FAWICK Standardized Press Application) CB Clutch	8″ to 36″	4,290 to 172,000	
CS Brake	6″ to 24″	2,000 to 100,000	
LIQUI-COOL Clutch & Brake		4,500 to 200,000	

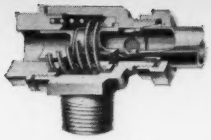
MAGNETIC

Applications: Oil or dry operation requiring high speed stops and starts, high cyclic rates, instant starting with heavy loads, or fast engagement and disengagement.

Torque Rating (in.-lbs.)						
In Oil		Dry		Body Bore	O.D.	Clutch Diameter
Start	Run	Start	Run			
27 to 34,000	35 to 44,000	40 to 51,000	50 to 66,000	¼″ to 3½″	2⅜″ to 13¼″	2″ to 13″

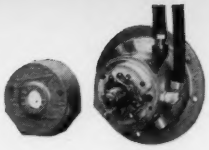


Single Passage Rotorseal

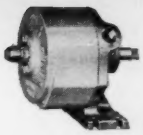


Quick Release Valve

Flexline Clutch Control



Timing Rotorseal



Cam Limit Switch

OPERATION	APPLICATIONS	SPECIAL CHARACTERISTICS	TECH DATA LITERATURE
Pneumatic Actuation Constricting Type	High Speed Cyclic Applications, General Power Transmission	Transmits Torque Through Rubber Side Walls, Complete, Automatic Disengagement, Drum/Friction Shoe Clearance Eliminates Drag, Acts as Clutch Coupling	ML-176-A ML-172 500-A2
Self-Energizing, Spring Engaged — Air Released, Constricting Type	Any Heavy Duty Cyclic Application, Fail-Safe Applications	Automatic Engagement at Any Time of Pneumatic or Electrical Failure — Simple, External Adjustment	ML-99-A ML-161 500-A2
Pneumatic Actuation Constricting Type	Severe Clutch or Brake Duty With High Starting Load or Sustained Slippage	Rapid Heat Dissipation, Low Diametral Size, High Torque Capacity	ML-102-A
Pneumatic Actuation Expanding Type	Medium Speed Cyclic Operation, High Acceleration Loads, Slip Clutch and Tension Brake Applic.	Heavy Duty Construction Resists High Heat Generation	500-A2
Pneumatic Actuation Expanding Type	Slip Clutch Application With Severe Heat Build-Up, Heavy Duty Service	Ventilated Shoe Aids Rapid Heat Dissipation; Relinable in the Field	500-A2
Pneumatic Actuation Expanding Type	Slow Speeds, Moderate Starting Loads, Light Torque for Continuous Slip Service	Transmits Torque Through Rubber Side Walls, Unusually Compact Mounting	500-A2
Pneumatic Actuation Expanding Type	Flexible, Disconnectable Coupling for Engagement at Standstill or Low RPM	Rubber Friction Surface Provides Maximum Torque for Small Diameter	500-A2
Spring Engaged, Air Released, Constricting Type	Extreme Heavy Duty Cyclic Jobs Requiring Exact Stopping	Same Effectiveness in Both Rotational Directions, with Extreme Self-Energization	ML-182
Pneumatic Actuation Constricting Type Self-Energizing, Spring Engaged—Air Released, Constricting Type, Fail-Safe	Power Press Package Application, Also Adaptable to All High Speed Cyclic Machinery Requiring Precise Automatic Control of Single, Continuous or Inching Operations	No Backlash, Simplified Installation, Provides Manpower and Machine Protection, Reduces Flywheel Overhang	ML-172 500-A2
Air, Water or Hydraulic Fluid Actuation	High Inertia Starting & Stopping, Constant Tension Braking, Continuous Slip Clutching, High Rotational Speeds	Large Operating Pressure Range (0-75 psi), Rapid Heat Dissipation, Light Weight, Low Coolant Usage	ML-181

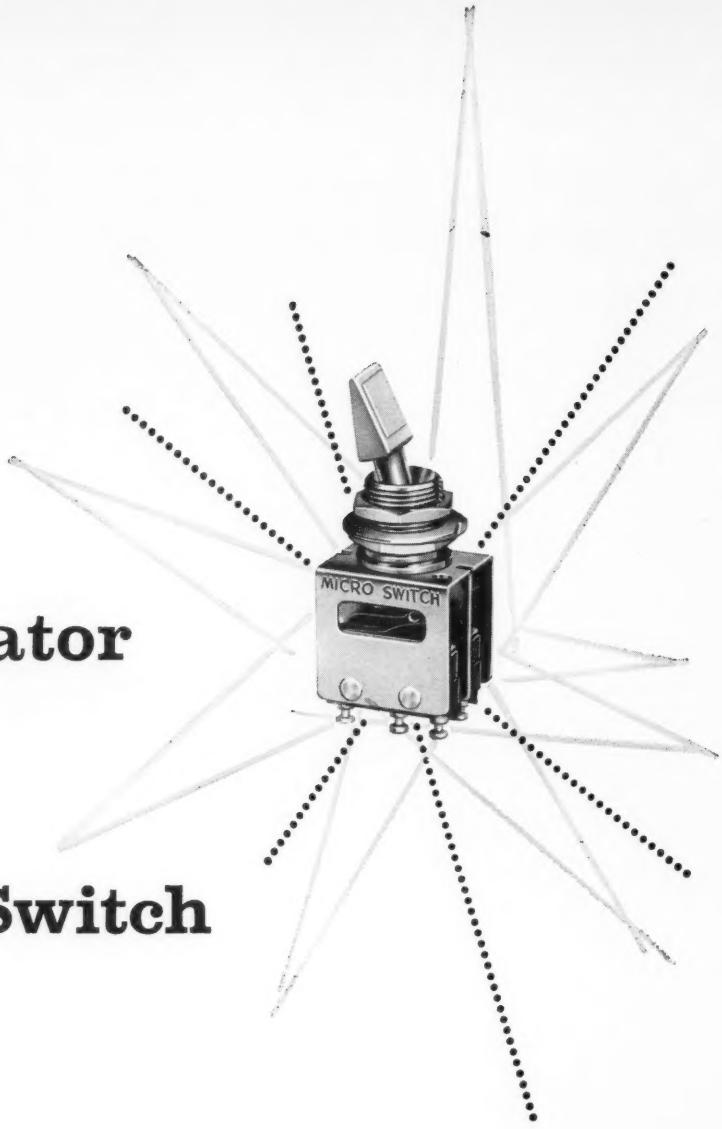
FAWICK AIRFLEX DIVISION
FAWICK CORPORATION
9919 CLINTON ROAD • CLEVELAND 11, OHIO
Fawick Canada, Ltd., 60 Front St., West, Toronto, Ont., Canada

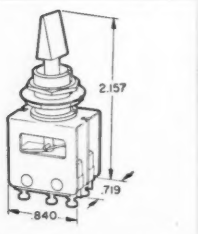
FAWICK AIRFLEX

INDUSTRIAL CLUTCHES AND BRAKES

For further information mark No. 134 on Readers' Service Card

New Tab-Indicator Toggle Switch





"400" SERIES TOGGLE SWITCHES
Five models available, including 2-position and 3-position types. All are rated at 5 amperes, 250 vac.

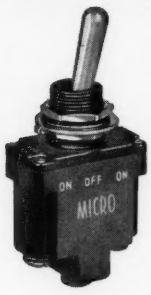
The new "400" Series Toggle Switch from MICRO SWITCH has a paddle-shaped tab which can be numbered or color-coded as an indicator. The standard model has a natural metallic finish which will maintain a fresh appearance through long and constant use. The anodized aluminum tab is also available in black or in colors.

The basic switches used are precision snap-action, long-life units, requiring a minimum of space. They conform to specifications for MIL-S-6743, with two isolated single-pole double-throw circuits. Turret terminals make wiring easy, and contact enclosures are dust-tight.

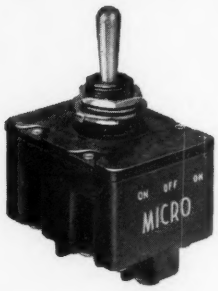
Five models are presently available in the "400" Series, including both momentary and maintained contact types. Write for Data Sheet No. 174 describing these new tab-indicator toggle switches.

H HONEYWELL

MICRO SWITCH Precision Switches



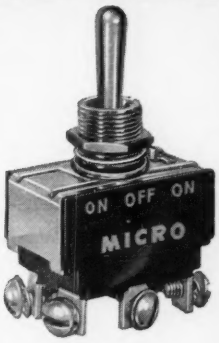
"1TL" Series



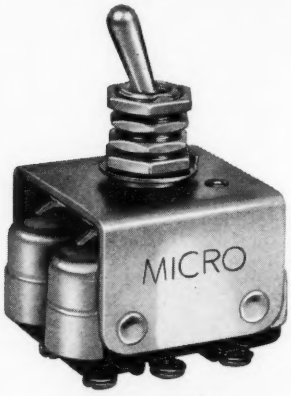
"4TL" Series

"1TL" Pull-to-Unlock

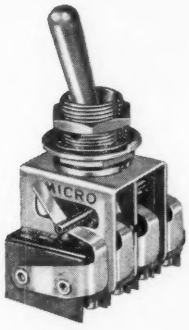
1-Pole "TS"



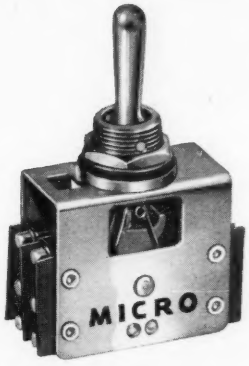
2-Pole Sealed "TS"



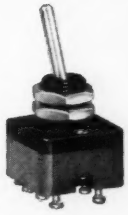
Hermetically Sealed Assembly



4-Switch Assembly



"Electrical Memory" Assembly



Subminiature "TM"

Precision Toggle Control Can Be Customized

MICRO SWITCH manufactures hundreds of different toggle switches and toggle switch assemblies. In this complete line you can find the exact characteristics and contact arrangements you need.

"TL" Series Silicone sealer between cover and case seals against dust or moisture. These switches are approved under MIL-S-3950A, operate in a temperature range of —85°F to +250°F. Available in 1, 2 and 4-pole models with integral terminals.

"TS" Series The toggle lever is sealed against dust and moisture. "TS" toggles meet specifications for MIL-S-3950A. Special plastic barrier plus extra distance between terminals. A keyed bushing prevents rotation. Wide choice of contact arrangements includes 1, 2, 3 and 4-pole types.

Subminiature "TM" Weighs only 4½ grams, measures only ½" x ½" at the base. Double-pole double-throw with wide temperature range and low circuit resistance.

"AT" Series Toggle Assemblies MICRO SWITCH offers toggle switch assemblies of up to 16 basic switches. Hermetically sealed types are also available.

For prompt engineering help on the selection of toggle switches, call the nearest Honeywell office or write Honeywell Controls Limited, *Precision Components Division*, Toronto 17, Ontario. Ask for Catalogue 73.

H HONEYWELL **Honeywell**

MICRO SWITCH Precision Switches

For further information mark No. 142 on Readers' Service Card

The new LICON® line . . . precision switches for every need

In the new, broadened Licon line you'll find every switch designed to meet modern high capacity, long life requirements. These are switches built to do today's tough jobs. Typical is the unique Type 16—heart of many Licon switch assemblies—tiny in size but rugged enough to handle big switch loads with unbelievable life. Check the unusual "specs" of the Type 16, and all Licon types, against your switch needs—see and compare Licon life against any switch—we're sure you'll specify Licon.

Send for catalog on new broad **Licon** *line*

—Gives handy dimensional data and engineering specifications you'll want to keep for ready reference.

Type 30 Enclosed Limit Switches—Interchangeable components form up to 16 switch types for quick replacement. High quality, compact, low-priced. 15A., 125V a-c—for industrial applications.

H—Hermetically sealed Switches—Designed for dependability in extreme environments. Unique, true hermetic sealing against dust, moisture and other elements. Designed especially to your application.

Type 14 Heavy-duty Switch—Built for heavy industrial and machine tool service. Rugged snap-action has large contacts rated 20 amps at 250V a-c.

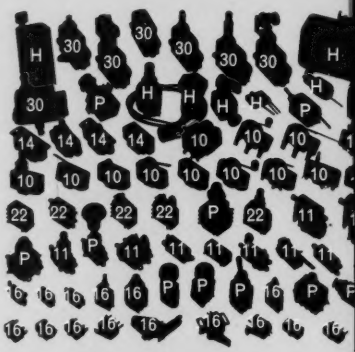
Type 10 Long-life Basic Switch—New Serpentine action mechanism delivers 10 million operations without failure. Can be provided with movement differentials as low as .0005". Rated 15 amps.

Type 22 Double-pole, Double-throw Switches—Provide positive control of four independent circuits. Simplifies controls for multiple circuit applications—withstands 25G at 2000 cps. Rated 15 amps., 125/250 V a-c, 30V d-c (res.).

P—Panel-mounted Switches—Variety of types—to 8 or more poles—some solenoid reset or magnetically held—sealed and unsealed as required.

Type 11 Snap-action Switches—Resist 50G vibration to 2000 cps. Double-break, snap-action design eliminates dead break, contact welding and provides greater capacity. Rated 10 amps., 125/250V a-c, 30V d-c.

Type 16 Subminiature Switches—Here's big-switch performance in a tiny unit. Only ¼" thick, 25/32" long—yet rated 10 amps, 30V d-c ind. Greatest shock- and vibration-resistance of any switch in its class on the market . . . even near trip point.



LICON

SWITCHES AND CONTROLS
DIVISION OF
CANADA ILLINOIS TOOLS LTD.
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Don Mills, Ontario

Exclusive Sales Agents
CONSTELLATION COMPONENTS LTD.
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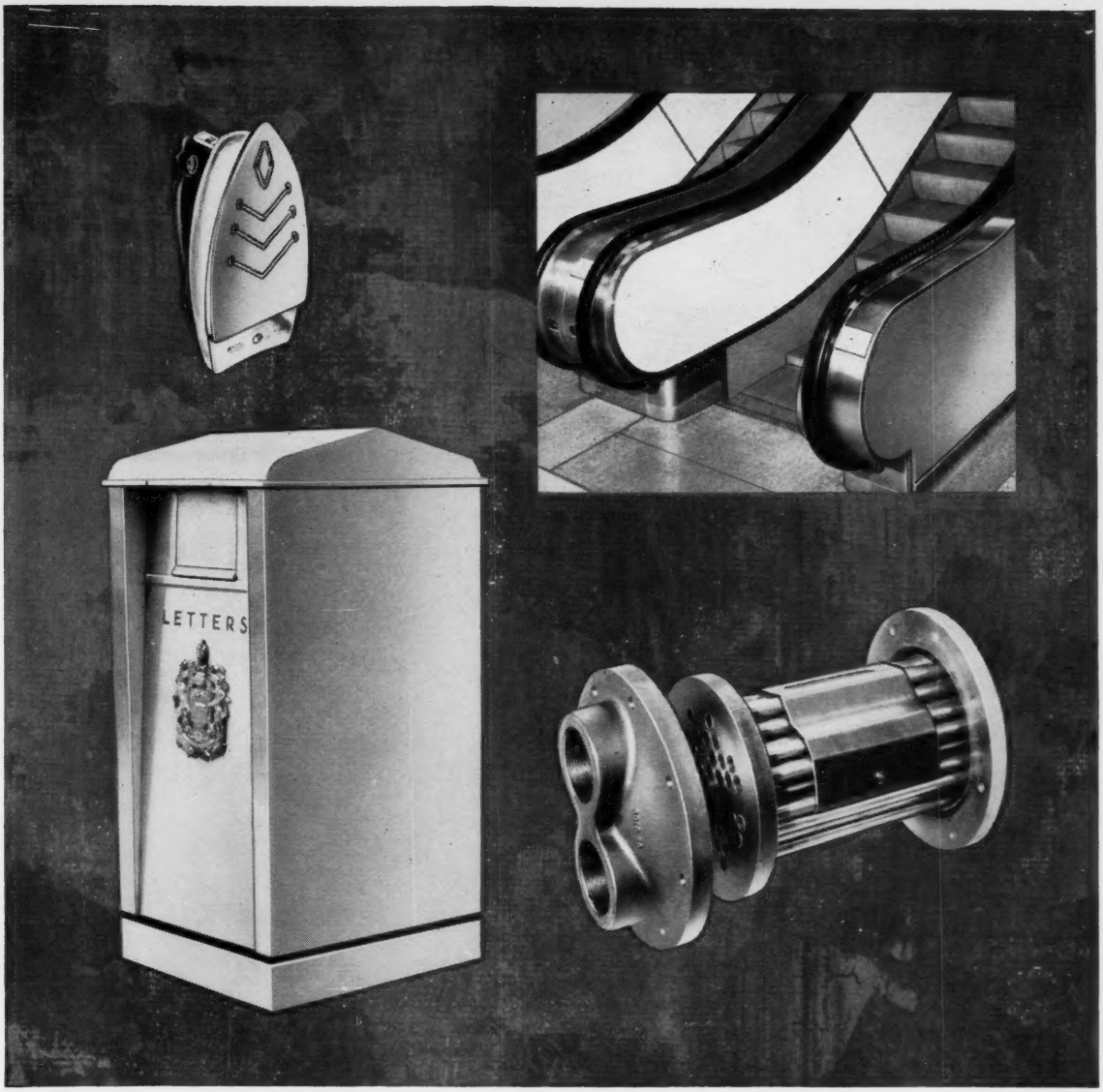


EVERY DAY A DESIGN PROBLEM IS SOLVED WITH STAINLESS STEEL FROM ATLAS

Every product presents its own particular problems—and it's the design engineer's job to anticipate these problems and solve them. Usually he turns to proven and accepted materials to keep production delays to a minimum. In every Canadian manufacturing industry this major requirement has meant just one specification —stainless steel from Atlas.

Why Stainless?

First of all stainless cuts down on expensive operations because it is easy to work with. No tolerance is needed for corrosion because there *is* no corrosion—and stainless needs no painting or plating.

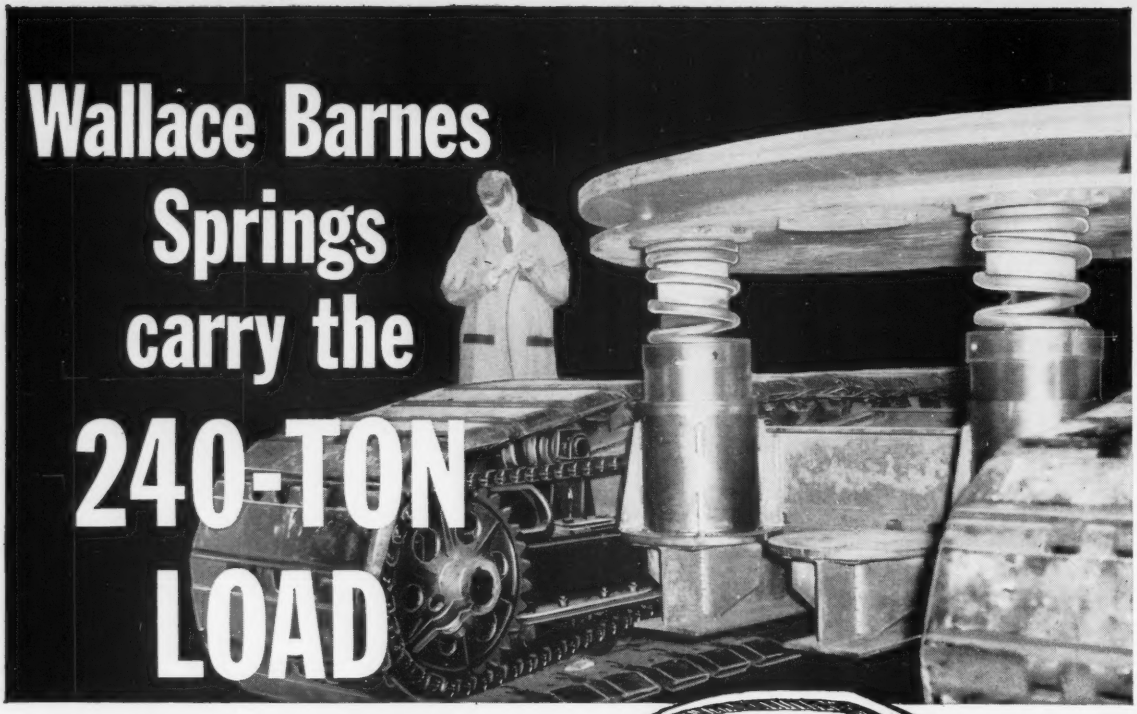
Investigate the possibilities of using stainless in *your* next project. In Canada the largest producer of Stainless Steels—and the company best equipped to assist you —is Atlas. For answers to your questions about steel, contact your nearest Atlas representative.

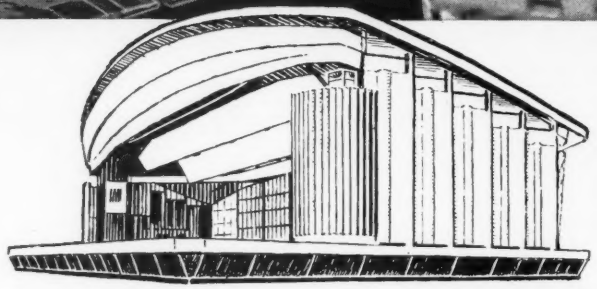
ATLAS STAINLESS STEELS

ATLAS STEELS LIMITED, WELLAND, ONT. Warehouses: MONTREAL, TORONTO, HAMILTON, WINDSOR, WINNIPEG, VANCOUVER. Representatives: LONDON, ST. CATHARINES, SUDBURY

For further information mark No. 105 on Readers' Service Card

Wallace Barnes Springs carry the 240-TON LOAD of the CNE MOVABLE STAGE





The Canadian National Exhibition was faced with the problem of providing football facilities for the Toronto Argonauts immediately before and after the annual Grandstand Show, without the week-long delay of building and dismantling the stage.

Would a movable stage solve the problem? (The stage is 160 ft. long, 80 ft. wide, 40 ft. high, and weighs 240 tons!)

Consulting engineers designed a stage that could be mounted on electrically powered crawler tractors to transport it on and off the field.

MOVING STAGE "FLOATS" ON SPRINGS

To protect complex lighting equipment and elaborate mechanisms, giant springs were designed to support the 240 ton load while being moved. Wallace Barnes constructed huge, 90 lb. hot wound compression springs to cushion the stage during the 400 ft., 5 minute move. 44 of these springs were required to distribute the load throughout the 12,800 sq. ft. base. Trial runs proved that the stage could be moved smoothly without undue jarring or stress.

This is the first stage of its kind in the world and CNE officials are confident that it will pay its way by allowing football and other field activities to take place immediately before and after the annual 3-week Grandstand Show.

The Wallace Barnes Company Ltd.

Hamilton, Ontario—Montreal (Pointe Claire) Quebec

Sales Agent: E. A. Tipping Sales Ltd., Winnipeg—Vancouver (Richmond)

Subsidiary of Associated Spring Corporation

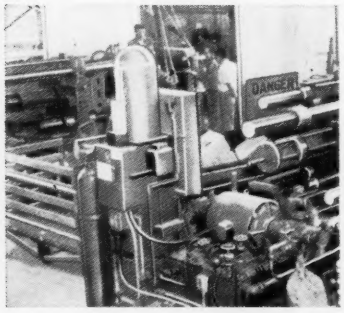
For further information mark No. 183 on Readers' Service Card

New Facilities
for aluminum die-castings

Modern, precision equipment at Hoover assures top quality and fast delivery

New operational methods and facilities enable Hoover to offer a die-casting service that is second to none. This expansion is reflected throughout the entire Casting Division.

From design-engineering to final inspection the emphasis at Hoover is on modern methods, efficient equipment and careful craftsmanship.



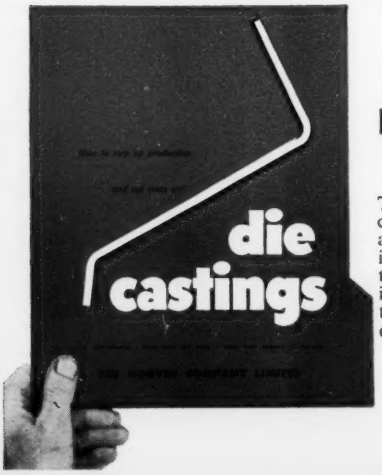
Hoover's die-casting section (above) has machines with ratings up to 600 tons, that can produce aluminum die-castings in quantity from the smallest practical size up to 14″ x 14″.

Trimming, finishing, buffing, machining and painting facilities (partially pictured below) enable Hoover to deliver castings in every state of finish, from "as-cast" to the finest commercial surfaces.

Scientific sampling and thorough testing of finished castings assure consistently high quality and strict adherence to specifications.

When should die-castings be used? There is no simple answer to this question. Generally speaking, die-castings should be used when reduced machining costs, intricate shapes, economy, attractive appearance and durability are factors.

Contact Hoover Die-Casting Division to learn if this precision technique will cut *your* costs.

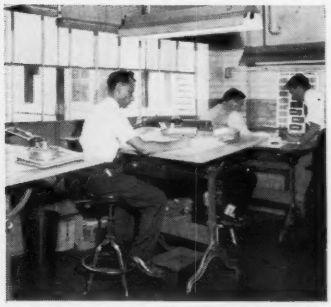


Send for this
FREE
DIE-CASTINGS HANDBOOK

This informative bulletin on aluminum die-casting will guide you in choosing alloys, and in the design of castings. Hints are included to help you take advantage of the die-casting process. You will also be interested in a detailed picture story that traces the production of die-castings from drawing board to final inspection. Write to

HOOVER
Die-Casting Division,
Hamilton, Ontario

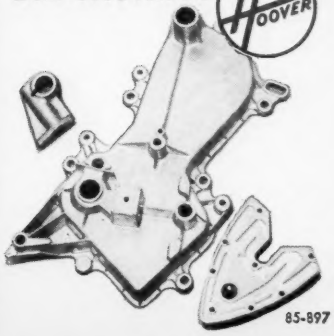
HOOVER
has the DIE-CASTING know-how



to produce castings at lowest costs

Hoover engineers have a tremendous fund of specialized experience in die-casting. Their knowledge is at your disposal. They welcome the opportunity to discuss your die-casting problems, and to assist in the design of components that will cut your costs and improve your product.

HOOVER
DIE-CASTINGS



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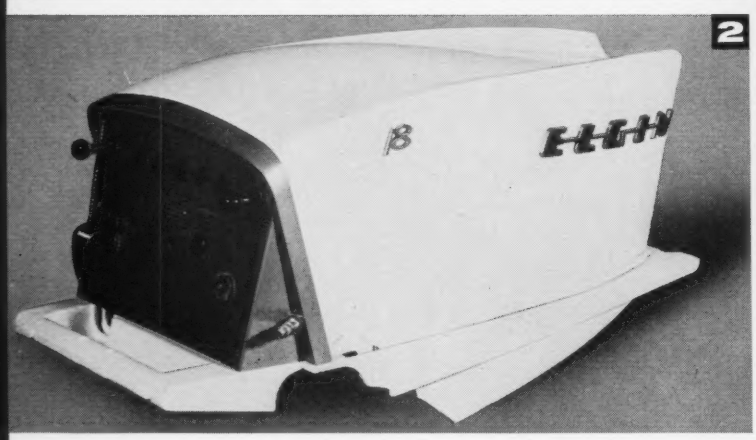
ACHIEVEMENT AWARD WINNERS

CHOOSE CHEMCELL PLASTICS

Material is part and parcel of good design. That is why Canadian Chemical Company is proud of having supplied the plastics for these winning designs . . . three more contributions to the continual expansion of the use of plastics. The awards were presented at the 1960 S.P.I. Conference, held in London, Ontario.

1



2

3

1 THERMOS ® LUNCHPAK — Moulded in Chemcell Fortilene* (high density polyethylene) by Plastene Company. This durable Lunchpak is far superior to any metal pail. It's light in weight . . . takes plenty of abuse . . . and it's colour-fast.

2 COVER FOR "ELGIN" OUTBOARD MOTOR — Chemcell polyester resin was used in the moulding of this cover. Moulded by Protective Plastics Limited, it is tough, scratch-proof, rust-proof and absorbs sound.

3 FORTALITE ® ATHLETIC GUARDS—Knee cap and shin-guard, moulded from Chemcell Fortilene* by Trans-Canada Plastics Limited. They are strong and tough even at low temperatures, light in weight and are unaffected by water. This equipment is used widely in the National Hockey League.

TO KEEP ABREAST of the latest developments in plastics, take advantage of Canadian Chemical Company's customer services. Literature and technical assistance are readily available at the sales office nearest you.

CANADIAN CHEMICAL COMPANY, LIMITED
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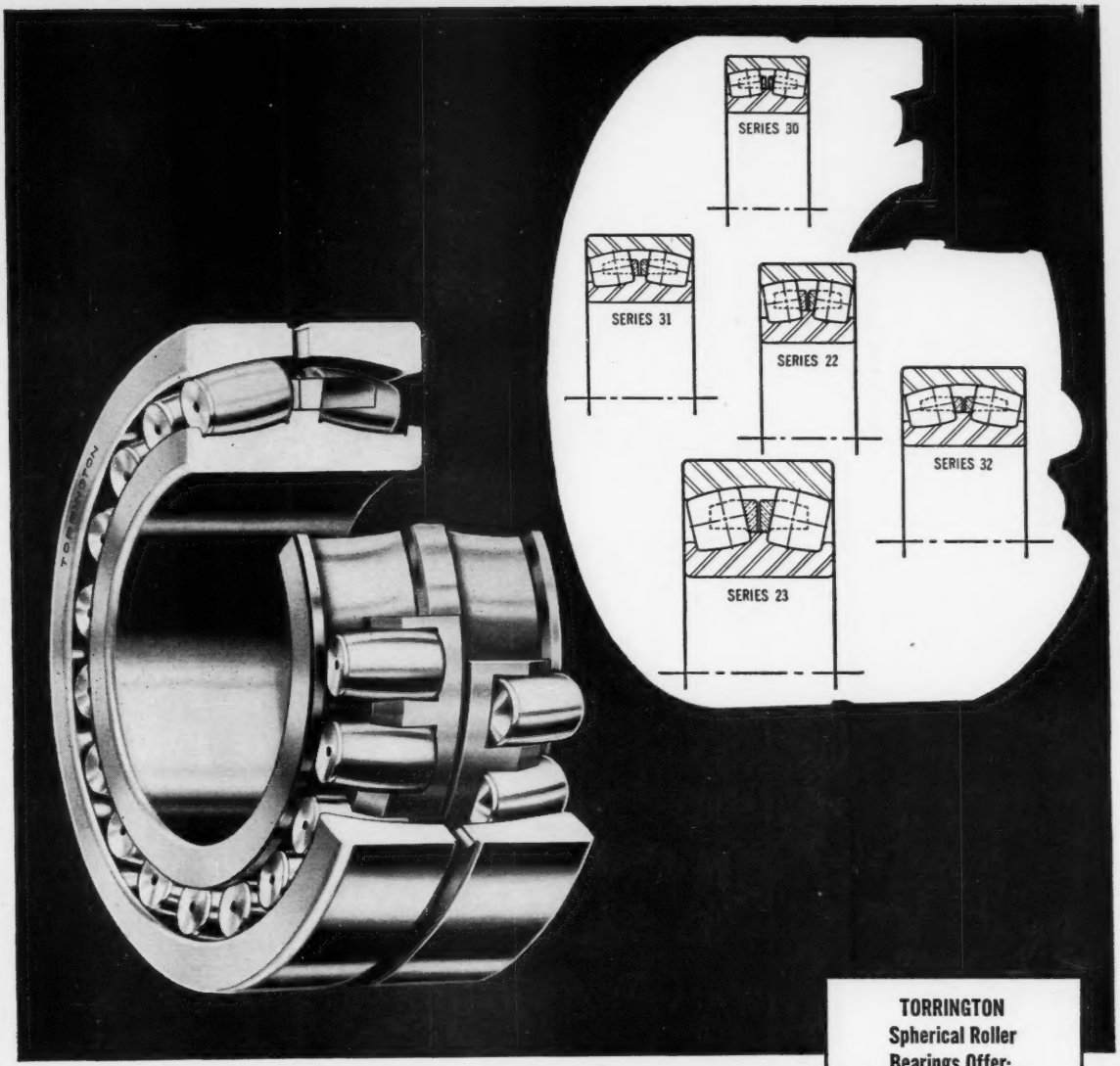

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Bearings matched *exactly* to the job pay off in better performance, longer life, greater reliability. That's why it pays to specify carefully. And that's why it pays to choose Torrington Spherical Roller Bearings.

Whatever your space limitations or capacity requirements, the five series of Torrington Spherical Roller Bearings provide the right bearing for virtually every industrial application. You can design for straight bore or tapered bore with adapter. You can benefit from extra features such as lubrication groove and oil holes, or selected outside diameters.

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- controlled internal clearance
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- even load distribution
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STEERING AXLES
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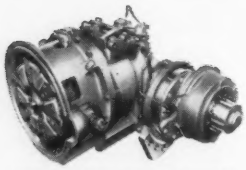
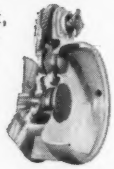
PLANETARY AXLES
over 50 models, drive and steer:
6,500 to 120,000 lbs



AXLE-TRANSMISSION UNITS
agricultural and industrial

POWER TAKEOFFS
Flywheel, countershaft, and conventional types



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One source:

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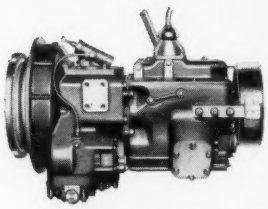


TRANSVERTERS
torque converter-clutch-transmission packages

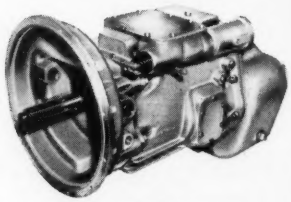
Whatever your needs in power transmission equipment, chances are you can get it from Clark.

Even more important, chances are a Clark unit *now in standard production* will do the job for you.

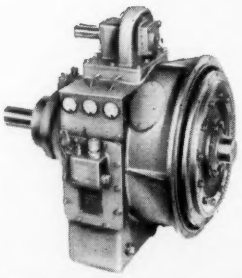
For Clark's Automotive Division, in its nearly 60 years of specialization in the power transmission field, has developed what is probably the broadest line of heavy-duty axles, transmissions, and torque converters available today.

The savings are obvious. Proven performance. Lower cost. And faster delivery.

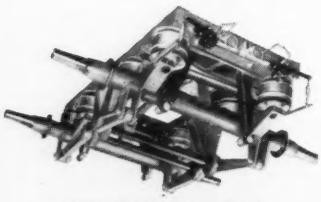
Write us for full details regarding any of the products shown.



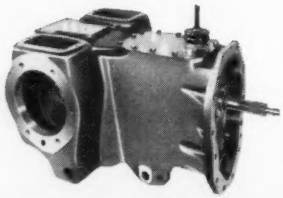
TRANSMISSIONS
50 to 1400 lb-ft torque ratings



TORQUE CONVERTERS
9″ to 28″ diameters



AIR SUSPENSIONS
single, tandem, and spreads; up to 36,000 lbs



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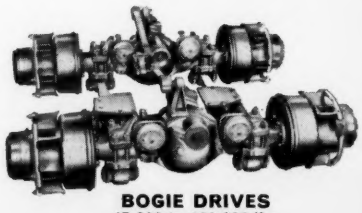

BOGIE DRIVES
45,000 to 180,000 lbs

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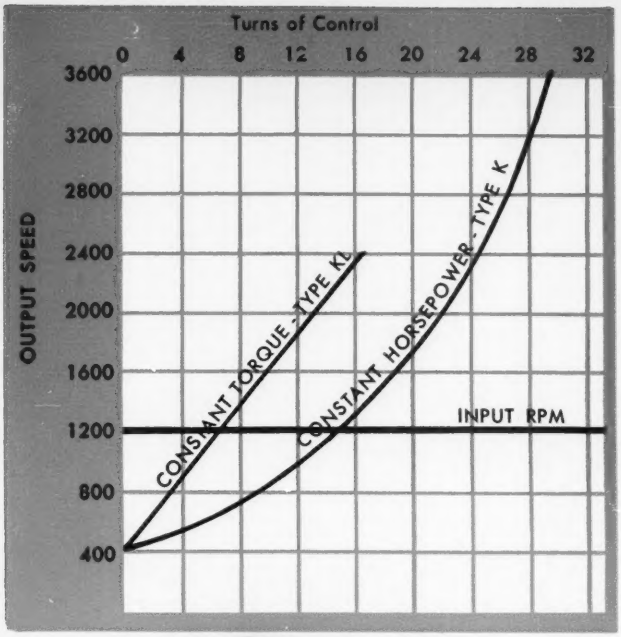
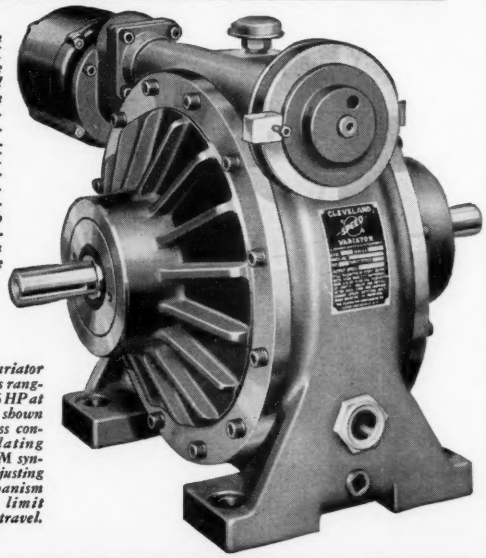


Typical speed regulation curves for the Types K and KL Variators. Type KL offers a linear speed regulating pattern, often an advantage in automatic control applications. Output speed regulation of the Type K Variator follows a geometric progression pattern. Starting at the minimum output speed, each turn of the speed regulating wheel produces a fixed percentage increase in output shaft speed.



The Cleveland Speed Variator is available in 18 models ranging from fractional to 16 HP at 1750 input RPM. Unit shown at right, used in process control, has speed regulating worm driven by 75 RPM synchronous motor, with adjusting shaft indicating mechanism modified to actuate limit switches to prevent overtravel.

CLEVELAND SPEED VARIATOR

Accurately Provides Dependable, Infinitely Variable Speed Control

ANNOUNCED late in 1954, the new Cleveland Speed Variator met instant, enthusiastic acceptance. Engineers and designers of industrial equipment already have put thousands of units into use on such varied equipment as cigarette making machines, textile machinery, metalworking machinery, pharmaceutical equipment, transfer tables, conveyors and experimental and testing equipment of many types.

Infinitely variable, the Cleveland Speed Variator gives stepless speed over a full 9:1 range—from ⅓ to 3 times input speed. Output speed can be adjusted by either a hand wheel on the Variator or by manual or automatic remote control.

The Cleveland Speed Variator offers these major advantages:

1. An extremely compact unit with input and output shafts in line and rotating in the same direction.

2. Almost any input speed up to 1800 RPM can be used—either clockwise or counterclockwise rotation.

3. Rated for constant horsepower output over a 9:1 or 6:1 range; or for constant output torque over a 6:1 range.

4. Speeds infinitely variable over entire range of adjustment.

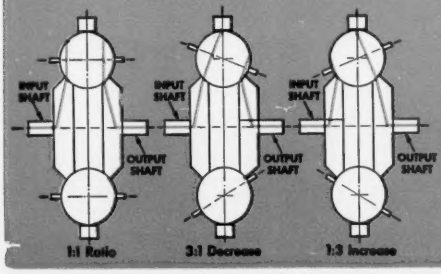
5. No slippage—positive torque response mechanism adjusts in direct proportion to the loads encountered.

6. Long life and minimum maintenance due to absence of belts or complicated linkages.

7. Ample bearing support for overhung pulleys on both input and output shafts.

Write for Bulletin K-200 for detailed description with photographs, sectional drawings, rating tables and specifications.

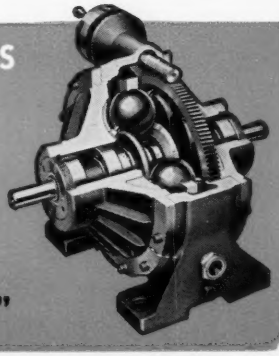
HOW THE CLEVELAND SPEED VARIATOR WORKS



Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts.

Relative speeds of the shafts are adjusted by changing the positioning of axles on which the balls rotate (diagram, right, shows cutaway Variator with hand regulating wheel).

"It's the Drive That's on the Ball."



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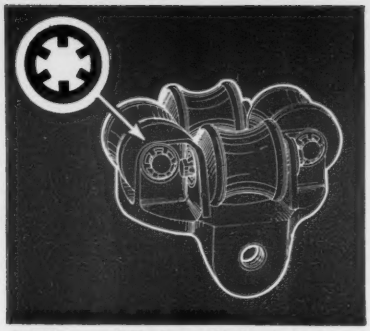
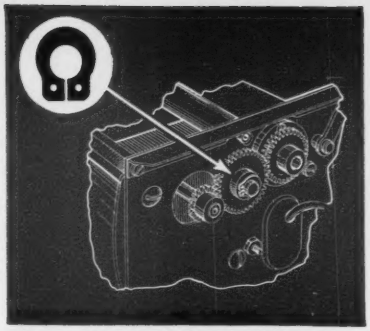
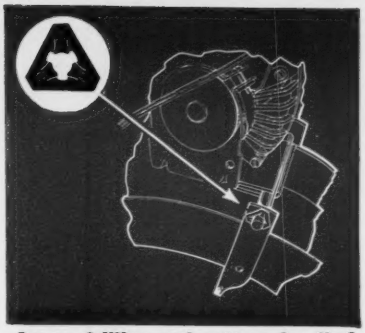


Drilling and flaring eliminated. Easier maintenance, a time saving of 50% and elimination of costly, time consuming drilling and flaring operations result when Truarc Series 5115 self-locking rings are used to retain rollers on pins in this electric cable guide. Extra long prongs enable ring to accommodate wide shaft tolerances.

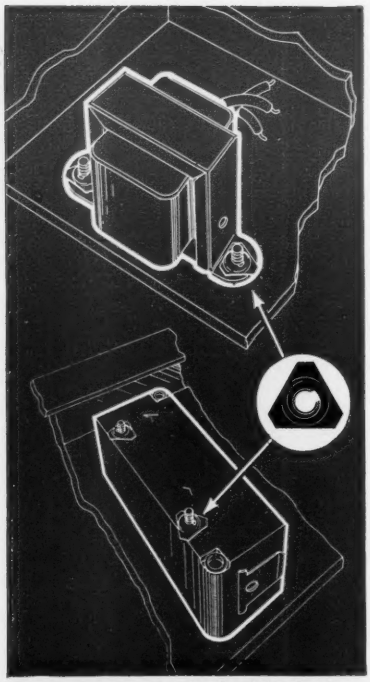


Economical fastening for idler gear. Installing Truarc Series 5555 Grip Ring flush with hub insures precise seating of gear in this portable electrocardiograph assembly. What's more, the ring eliminates a nut and costly stud-threading operation of alternate design. **Typical savings amount to $365 per 1000 units.**



Cross-drilling and cotter pin eliminated. Here a Truarc Series 5305 self-locking triangular retainer replaces a cotter pin used to hold an electric-motor mounting bar. Both the cotter pin and the cross-drilling operation required in the original design are eliminated. **Typical total savings amount to $120 per 1000 units.**

Truarc self-locking retaining rings boost economy in wide variety of designs



Easy way to mount electrical-electronic parts. Truarc Series 5300 triangular nuts replace conventional nuts and lockwashers in mounting electrical parts like transformer (top) or Microswitch (bottom). Dished body of Series 5300 flattens under torque, eliminates need for lockwasher, simplifies handling and assures assembly.

...eliminate parts, machining, speed assembly

Easy application, elimination of more expensive conventional fasteners and reduction or elimination of machining operations are just a few of the savings resulting from the proper use of self-locking retaining rings. Rings replace threaded retainers and nuts, hairpin-type cotter pins, and a variety of cut, lock, and plain washers. They require no groove, or preparatory machining operations. Rings can be installed by unskilled labor, seated at any point on the shaft, automatically taking up any accumulated tolerances.

Four ring types are shown. One has a dished triangular body which locks the fastener on the shaft under spring tension, holds under moderate shaft tolerances and against extremely heavy thrust loads. Another, a re-usable Grip Ring, is ideal for ungrooved shafts, tubes, bosses, and studs. A third type is a triangular free-spinning nut with a dished body that flattens under torque, eliminating need for separate lock washers. The fourth, a push-on type, has an arched rim to provide high strength and extra long locking prongs which accommodate wide shaft tolerances.

These are but four of the 50 functionally different types of Truarc retaining rings. They come in 740 standard sizes, 6 metal specifications, 13 different finishes. The entire Truarc line, including assembly tools, grooving tools, and 80 typical cost-saving applications, is covered in the new catalog RR 10-58.

Available in Canada from: **LYMAN TUBE AND BEARINGS, LIMITED**

Head Office: 5420 Pare Street, Montreal 9, Quebec. Branch Offices: Toronto, Winnipeg, Vancouver, New Glasgow, N. S.

WALDES TRUARC® RETAINING RINGS

Waldes Kohinoor, Inc., Long Island City 1, N. Y.

TRUARC RETAINING RINGS . . . THE ENGINEERED FASTENING METHOD FOR REDUCING MATERIAL, MACHINING AND ASSEMBLY COSTS

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Specify rubber maintenance products made of Du Pont neoprene or HYPALON . . . they often outlast ordinary rubber goods. For example:

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HYPALON coated nylon tarpaulins will not crack or dry out; highly resistant to abrasion and cutting, yet ⅓ the weight of conventional tarps.

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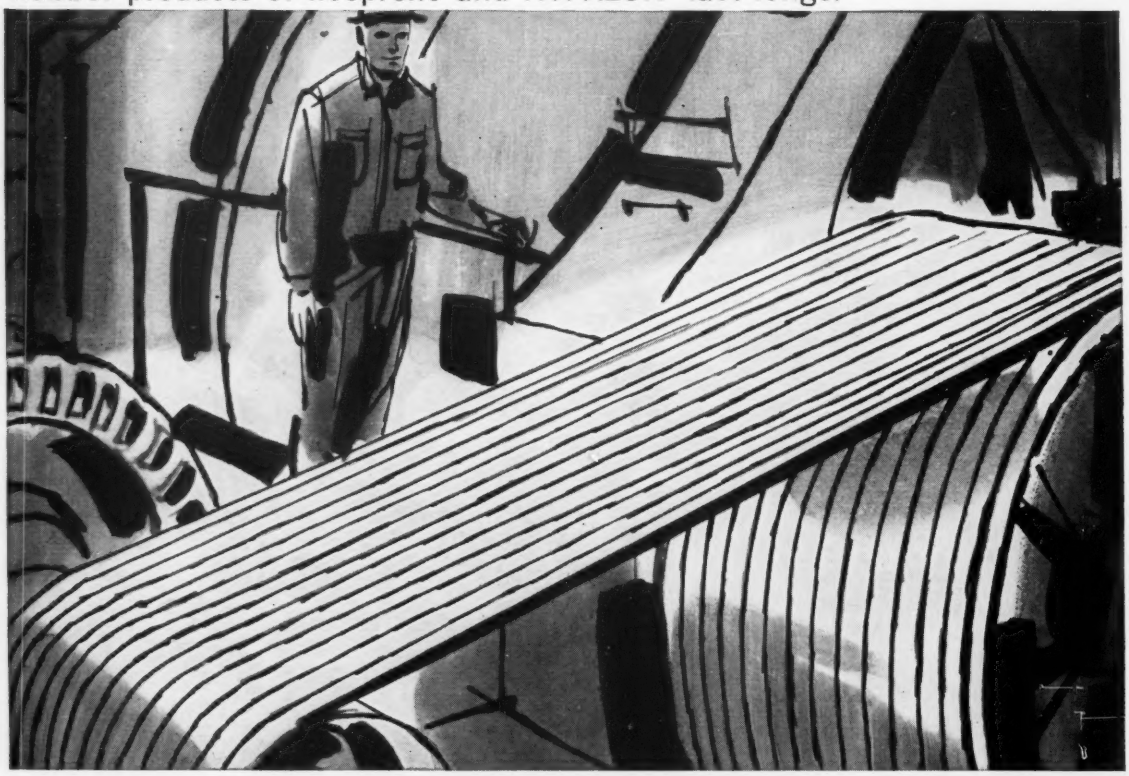
HYPALON hose has carried hypochlorite since May, 1954; ordinary hose broke down in a few months.

This means longer service per dollar, reduced replacement cost and savings in downtime.

Wherever you use maintenance goods of neoprene and HYPALON you are assured of durability, and excellent resistance to a wide range of deteriorating factors. Neoprene, a versatile synthetic rubber, offers good oil, weather and abrasion resistance. HYPALON is a special-purpose synthetic rubber, ozone-proof and impervious to most oxidizing chemicals.

Your local rubber goods distributor handles neoprene and HYPALON maintenance products and can recommend the right product to meet your needs. Take advantage of his knowledge and service by calling him soon. For additional information write for DU PONT ELASTOMERS IN INDUSTRY, Du Pont of Canada Limited, Room 400, 85 Eglinton Avenue East, Toronto, Ontario.

Rubber products of neoprene and HYPALON® last longer



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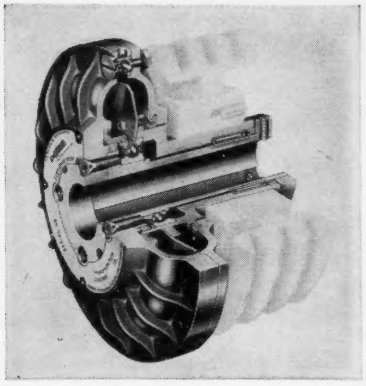
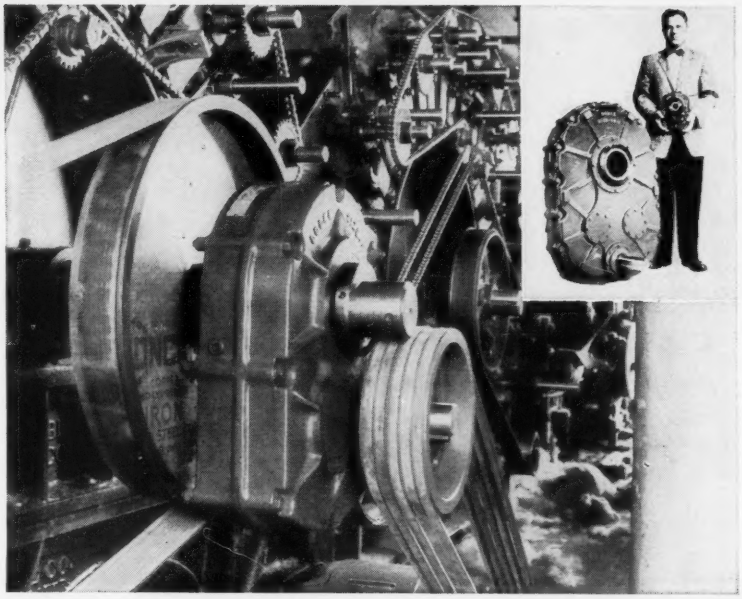
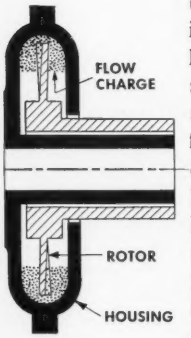
PRODUCT NEWS

FROM UNITED STEEL CORPORATION



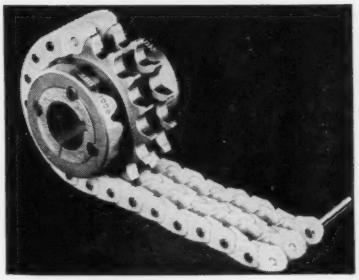


FLEXIDYNE "Dry Fluid" Drives and Couplings provide a new way to: start loads smoothly, protect against overloads; reduce maintenance; save on motors and controls. The "fluid" in Flexidyne is heat treated steel shot. A measured amount, called the flow charge, is contained in the housing, which is keyed to the motor shaft. When the motor is started centrifugal force throws the flow charge to the perimeter of the housing, packing it between the housing and the rotor which transmits power to the load. After the starting period of slippage between housing and rotor the two become locked together and achieve full load speed, operating without slip and with 100% efficiency. The Dodge Flexidyne Drive is available to handle from ¼ HP. to over 800 HP. **No. 6801.**



TORQUE-ARM SPEED REDUCERS— "Torque-Arm" is a precision built power package which simplifies problems of speed reduction and in so doing cuts the cost of equipment, installation and operation.

The reducer is mounted directly on the shaft to be driven thereby eliminating the need of costly linkage, foundation, sliding motor base or flexible coupling. Simple installation is effected by sliding the unit over the shaft and locking it in place with four screws. Combined with a V-Belt drive the Torque-Arm Speed Reducer can provide speed ratio up to 150-to-1 by selection of a predetermined combination of reducer and drive. Capacities up to 170 HP. with output speeds from 10 to 400 RPM. Overload Release and Backstop Mechanism, optional extras. **No. 6802.**



NYLON CHAIN COUPLING. Will outlast metal by as much as 6 to 1—costs less to buy and maintain. Specially suited for areas where corrosion is a problem. Ideal for loads fractional to 40 HP. and speeds 500 to 5,000 RPM. Used with standard ½″ pitch roller chain sprockets. Quiet running; requires no lubrication or covering. **No. 6803.**

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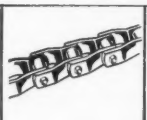
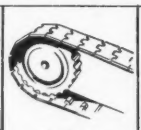


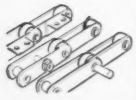
Mark 3 Offset-
Side Bar Chains



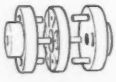
Slat Band

Chain Tools

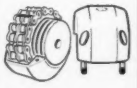
Stock Sprockets



Conveyor and
Elevator Chains



Disc Couplings



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Blood Brothers Drive Assemblies help give power "pay-off" in

TOUGH HOUGH PAYLOADER®

Many outstanding improvements have made this Hough Model H-90B Tractor Loader a proven leader in its field. Available with 1½, 3 and 5 cubic yard capacities, it offers a full 50° bucket-dumping angle, plus maximum lifting height and reach for loading large hauling units.

The lower-front drive shaft and lower-rear drive shaft used on this latest equipment were manufactured to exacting specifications by Blood Brothers. It is typical of the many quality drive assemblies Blood Brothers furnish for special equipment of all sizes.

Rockwell-Standard's Universal Joint Division offers a wide range of specialized engineering experience – involving everything from manual steering assemblies . . . to power take-off drives . . . to heavy-duty propeller shafts.

If you are planning or designing new equipment, consult our engineers for important savings in time and money. A letter or phone call will bring cooperative, friendly, experienced assistance.

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Another Product of

ROCKWELL-STANDARD CORPORATION

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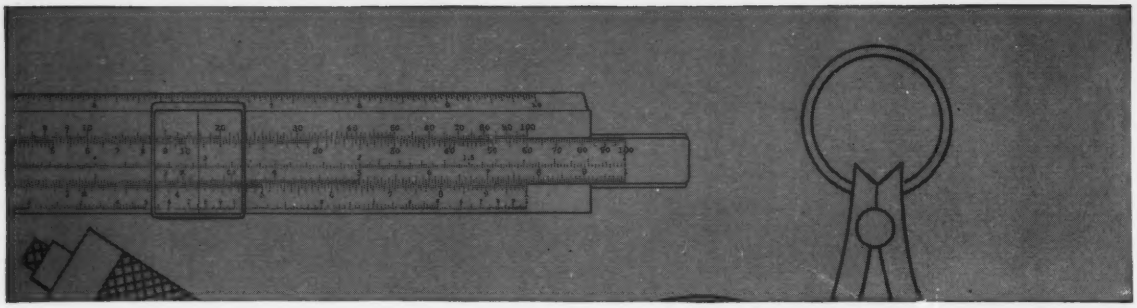
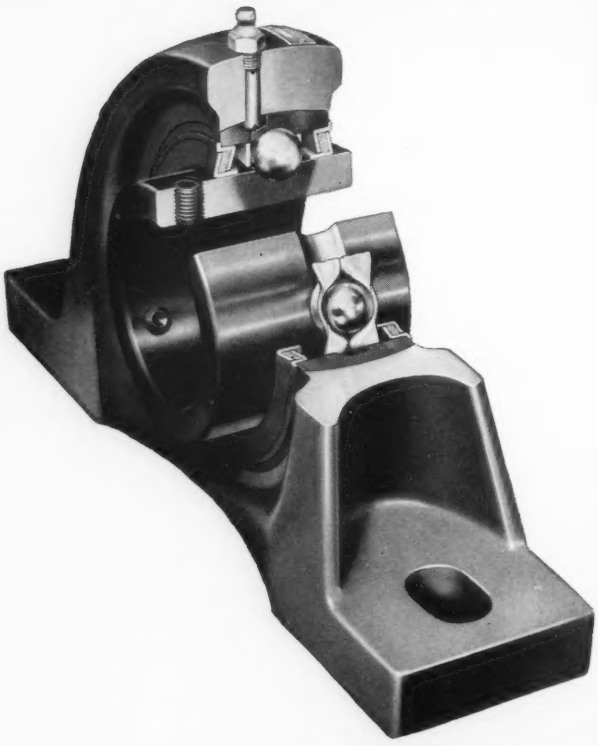
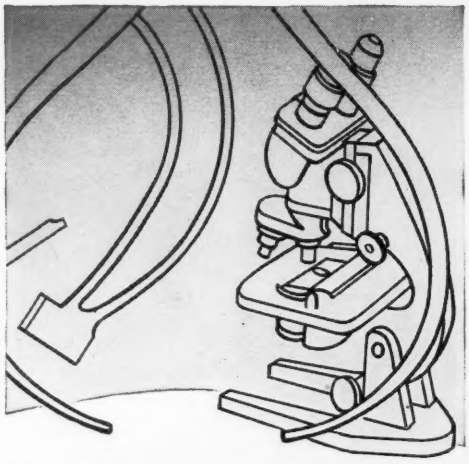


SYMBOLS OF PRECISION





Like the Movement of a Fine Watch...SEALMASTER Bearing Units Are Precision Built!

No component you buy for the products you build or operate will be more precisely engineered than the SEALMASTER Ball Bearing Units. From design boards to finished product SEALMASTER Bearings are the product of quality materials and manufacturing processes. Every bearing unit before leaving the SEALMASTER plant has been checked and rechecked to be certain it is worthy of bearing the SEALMASTER trademark. This insurance of quality has made the word SEALMASTER symbolic with Precision wherever bearings are used.

Write for your FREE copy of SEALMASTER Catalog 454.

S234C

SEALMASTER BEARINGS A DIVISION OF STEPHENS-ADAMSON MFG. CO. OF CANADA LIMITED, BELLEVILLE, ONTARIO

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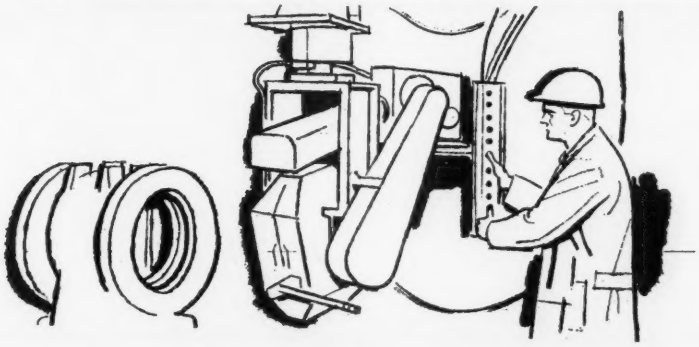
Dofasco technicians offer their specialized knowledge of metallurgy, casting design and foundry methods to give you the best castings at the lowest cost.

FROM CONSULTATION



Follow through by Dofasco technicians is your assurance of prompt delivery and of quality. For definite proof of freedom from flaws, your castings can be radiographed on the Cobalt Camera, as an additional service.

TO INSPECTION...

Dofasco Casting Technicians

stress Quality and Service

Dofasco is justly proud of its reputation for prompt delivery — but *quality* is never compromised for *speed.*

Speed and quality go hand in hand, because Dofasco's fully equipped foundry uses the most modern, efficient methods under the guidance of experienced technicians who have your interests at heart.

Whatever your casting needs . . . one or a thousand . . . large or small . . . complex or simple . . . call on Dofasco for quality castings *on schedule.*

DOMINION FOUNDRIES AND STEEL, LIMITED

HAMILTON, CANADA

Ask before you buy, ***"IS IT MADE IN CANADA?"***

For further information mark No. 128 on Readers' Service Card

THIS IS GLASS

A BULLETIN OF PRACTICAL NEW IDEAS FROM CORNING

NO PLACE FOR AN ACROPHOBE

When first we read of the seven who are eager to blaze a route to the stars, we pondered what we thought of as man's inborn fear of great heights.

Now we learn that the first of the astronauts will have a window in his capsule, that he will peer *down* at the spinning earth and *out* at the wheeling stars.

We are producing these unique, spacegoing viewports for McDonnell Aircraft Corporation, prime contractor for the National Aeronautics and Space Administration's Project Mercury capsule.

The window is an excellent piece of engineering. Not just because we made it, but because it *has* to be.

It will take the slams and whams, the blistering heat, and the embrittling cold of blast-off, orbitation, re-entry, and a soak in the briny. All during this it must remain transparent, intact, and sealed tight.

There are four panes to the window. The outer two are VYCOR® 96% silica glass. The inner two are aluminosilicate glass specially tempered to phenomenal strength.

Each pane is ground and polished to the precision finish of a telescope mirror. The outermost panel curves to the contour of the capsule, so it trapezoids from an 11″ base to a 7½″ top along a 21″ height.

The glasses present a delicate balance of optical qualities, thermal shock resistance, and low weight. The last is vital when you consider that it takes about 100 gm of fuel to orbit 1 gm of payload.

So, remember, when you see the first astronaut smiling quietly, confidently from his capsule, you are looking at him through Corning glass.

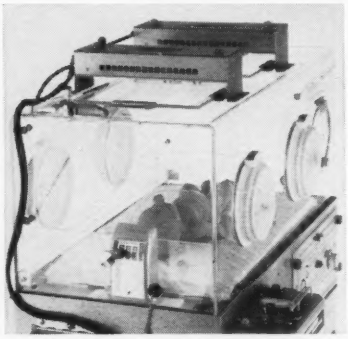
HOW ABOUT A DEGREE IN MEDICAL ENGINEERING?

The mechanics of modern medicine are fast maturing to the point where some engineers are specializing in the building of machines like this Infant Servo-Controller for the Isolette, manufactured by Air-Shields, Inc., Hatboro, Pennsylvania.

This particular machine is used with prematurely born infants who must keep their body temperature at a constant level, but lack a well-developed thermal regulatory device.

You attach a thermistor to the babe's abdomen and let him work as his own thermostat. He automatically requests heat from infrared lamps whenever his skin temperature drops below 97°F. When things are just right again, he switches off the lamps and takes a rest, with the odds for survival more in his favor.

If you've ever tried to unbulb an infrared lamp, you know that it gives off *direct* heat as well as IR energy.

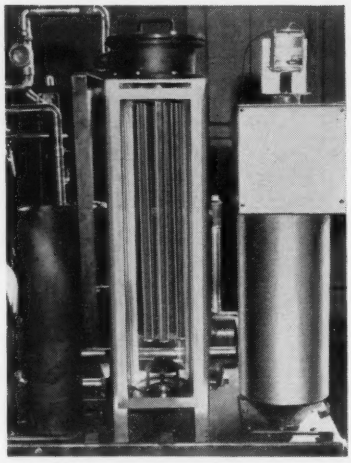


That's why there are two PYREX No. 7740 glass plates sitting on top of the plastic chamber in the picture. You can see them, if you look closely. The PYREX plates are heat resistant and will also dissipate the *direct* thermal output of the lamps. So, the plastic forgets the lamps are there.

As far as the IR energy is concerned, the PYREX plates don't exist either, so practically all the IR gets through to the baby.

The over-all relationship between IR and glass is an odd one. We can give you glass which transmits as much as 92% of the IR or a glass which transmits as little as 8% of the IR.

Happily for our product specialists, there is demand for both situations. We've prepared some bulletins on many of these IR characteristics, a copy of which you may have by sending the coupon.



SOMETIMES GLASS IS SO OBVIOUS

Leafing our way through the 4th Annual Shirt Issue of "Cleaning Laundry World" (April 1960), we took note of an advertisement which concerned a machine which displayed a feature which we consider the soul of genius.

The machine is a dry cleaner manufactured by Detrex Chemical Industries, Inc. The feature is a glass-enclosed filter which keeps the dry-cleaning solvent cycling unpolluted. The soul of genius, to our minds, consists of intelligent manipulation of the obvious . . . in this case, an application of the first known and longest respected of the myriad properties of glass . . . to wit, its *transparency*.

When you locate such a place, it doesn't necessarily take a lot of redesigning of custom fabrication to put glass to work, either. We checked and found that Detrex, for example, simply orders standard 6″ O.D. PYREX brand Heavy Duty Tube for its filter wall.

The result is that the operator of the Detrex Cleaner can watch the filter at work. He can spot trouble while it's still potential, determine its cause exactly should it occur . . . all without any dismantling or shutdown.

Is there anything you're working on that you wish you could watch working? If there is, and you want to put glass to work, you can start by sending the coupon for a copy of Bulletin IZ-1, "Designing with Glass for Industrial, Commercial, and Consumer Applications."

CORNING MEANS RESEARCH IN GLASS

CORNING GLASS WORKS, 399 Crystal St., Corning, N. Y.

☐ IR Transmitting Glasses ☐ IR Reflecting Glass ☐ IZ-1

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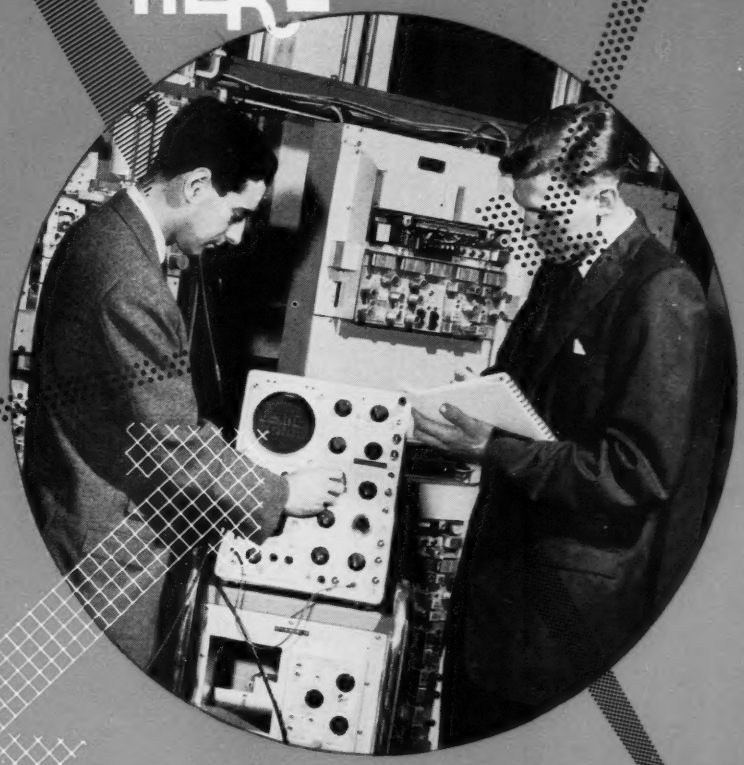
NEW VENTURES BEGIN HERE



In the modern laboratories of Northern Electric, new concepts in communications are constantly taking shape. Each project is approached with vigour, as a new and challenging venture, by a skilled research and development team — a group of men who keep their minds poised and eager to pioneer new techniques and improve established products — transistors, electronics, microwaves, carriers, video and audio.

At Northern Electric, research and development are setting the pace in the science of communications.

Research and Development Laboratories

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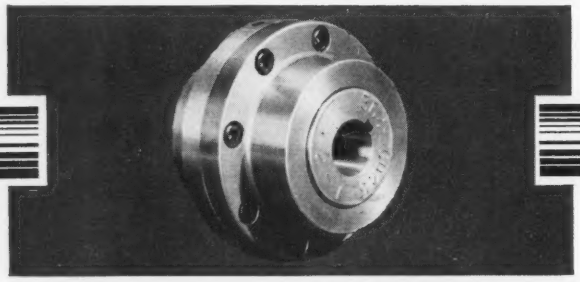
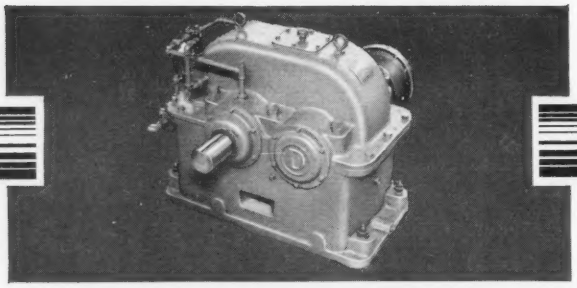
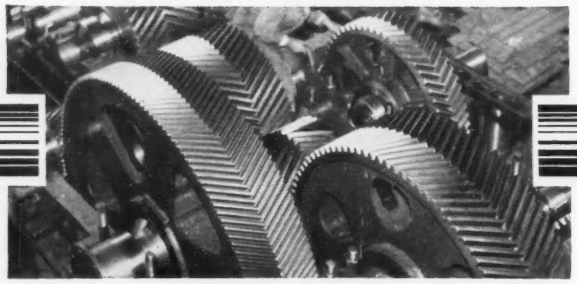
DOMINION



GEARFLEX COUPLINGS



GEAR UNITS



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The *right* connection—for *any* application: standard or special design—any size, type, ratio, horsepower.

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For further information mark No. 125 on Readers' Service Card

Miniature Soldiers. Army ants carry out intricate maneuvers of wheeling, flanking, and envelopment with faultless precision. Their columns are led by "majors", preceded by "scouts". Raids are conducted by "skirmishers". Between campaigns, they form "bivouacs". Army ants are nature's tiny troopers.

Miniature Ball Resolver, approximately 3⅜" x 2½" O.D. continuously calculates position of aircraft and missiles traveling at supersonic speeds. MPB bearings at critical points keep torque low, and help make possible an accuracy of 0.33 of 1%. This is another man-made miracle in miniaturization.

Man with Miracle. This is Dick Anderson, one of MPB's Sales Engineers, whose cooperation with customers includes expert aid in the application of miniature and instrument bearings. MPB's technical staff, most experienced in its field, can assist you with your own miracles in miniaturization.

Miracles in Miniaturization

ACTUAL SIZE OF THE MPB BEARINGS IN BALL RESOLVER SHOWN ABOVE

Every day man's advances, both on this planet and beyond, are opening new and challenging areas of application for miniature components and mechanisms. And at each step forward, MPB is ready to help with research, engineering and manufacturing facilities unsurpassed in the miniature bearing industry. MPB makes more than 500 types and sizes of bearings ranging from ⅜" O.D. down, meeting requirements of the most exacting nature. Specials developed on request. For a confab on design problems or our latest catalog write MPB distributor: **Lyman Tube and Bearings, Ltd.,** 5420 Pare Street, Montreal. Additional offices: Toronto, London, Winnipeg, Vancouver and New Glasgow.

MPB *Helps you perform miracles in miniaturization*

For further information mark No. 150 on Readers' Service Card

Design Notes on Fluid Power

RELEASE No. 1: "WHY DO YOU NEED FILTERS?"

Users of hydraulic equipment have one of the greatest built-in advantages ever devised in the machine-age. **the operating medium is a liquid!** This means that we can use an oil having excellent lubricating characteristics, which will continuously and thoroughly bathe all the moving parts of our machine, effectively checking wear. If the oil we use also has a corrosion inhibitor, we will also eliminate corrosion of internal parts.

We should, therefore, be able to keep our hydraulic pumps, valves, motors, cylinders, operating in peak condition for years and years and years . . . if we keep oil clean so that it will continue to lubricate.

If we do **not** keep the oil clean, it will gradually become contaminated with bits of dust, pieces of metal, chunks of rubber eroded from the packings, microscopical pieces of abrasive worn off grinding wheels, and many other specific or local hazards.

HYDRAULIC FILTERS

To keep your hydraulic oil clean, just follow these easy steps:

1. Keep the reservoir completely sealed during the extension and retraction of cylinders, the oil level in the tank will fluctuate, so you should use a "filter-breather" to filter out contaminants from the air breathing in and out of the tank.

2. Use a 100-mesh strainer in the suction side of the pump. Select a unit rated at least twice the G.P.M capacity of the pump.

3. Install a suction gauge at the pump inlet; this will tell you when the strainer needs to be cleaned, and warn you of excessively high vacuum at the pump inlet. For positive warning, use a vacuum switch wired to an alarm.

4. When you are using high-efficiency piston pumps and fluid motors, you should also install a micronic filter in the return line. You will be well advised to install a pressure gauge at the inlet to this filter, to warn you when the element is dirty and must be changed. Do not use filters with by-pass relief valves!!

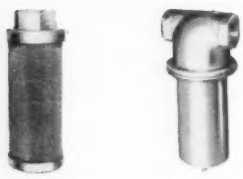
5. If your system has sensitive, close-tolerance components such as servo-valves, protect each one with a line-type high-pressure filter. Always install a differential pressure switch across the line filter to warn you when the element is dirty and needs to be changed.

6. Keep your oil temperature at a maximum of 130 to 140°F to avoid excessive oxydation, and change oil every 12 to 18 months.

In another release, we'll talk about heat and how to prevent it.

AIR FILTERS

Pneumatic systems also need filters to remove pipe scale, rust and dust particles which would otherwise plug valve orifices and cause wear of the cylinders or tools. A well-designed air filter will also remove all the moisture from the air. Some air filters are designed to remove oil fumes as well as dirt and water, and are particularly suited for instrumentation, where clean, dry, oil-free air is required.



Sump type Line type
CAPITAL STRAINERS,
10-mesh to 200-mesh

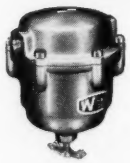
Micronic filter, suction or return, 150 psi. 10 micron and 5 micron. SPRAGUE.

Low-capacity Line-type, to 5000 psi. 140 micron to 5 micron. WATERMAN.

High-capacity Line-type, to 5000 psi. 10 micron and 5 micron. SPRAGUE.

WILKERSON
COMPRESSED AIR FILTERS

Manual Drain



Float-operated Drain

Piston-operated Drain

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Circle Number below to receive our "Filter" Catalogue.

ROUSSEAU CONTROLS LTD.

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With such a choice available, it often is possible to avoid the costs—in time and money—of special designs. However, if you have a particular problem, our salesmen or engineers will gladly assist you in selecting the right bearing for the job—standard or special.

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BOTH REDUCERS HAVE THE SAME CAPACITY!

This dramatic saving in weight and space is possible only because the reducer on the left has Philadelphia Precision Ground Gearing . . . a new development, so significant you can solve drive problems you could never solve before . . . because you get engineering advantages that have never been available before.

For the first time, standard commercial speed reducers are available with gearing of master gear quality. Extreme accuracy of profiles, profile spacing and surface finish reduce dynamic load factors. Harder gear materials can be used. Result: increased load carrying capacity without sacrificing performance characteristics.

Gear noise is reduced to the point where it is no longer a controlling factor in applications where low sound levels are important.

Backlash is reduced in reversing drives . . . and it is uniform where precision of movement is important.

Vibration is virtually eliminated because tooth to tooth errors, accumulated pitch errors and composite errors are reduced . . . smoother contact results.

Longer gear life. Improved accuracy and better surface finish eliminates "running-in" periods and the resulting wear on gearing.

If you have a new product on the boards . . . design changes coming up . . . or new drive requirements of any kind, Philadelphia Precision Gear Drives may give you the competitive edge you've been looking for. Write for full data on precision ground gearing in spiral bevel, parallel shaft and In-Line reducers as well as gearmotors and Motoreducers. If you have a special drive problem, the full facilities of our engineering staff are available to help you find the solution.

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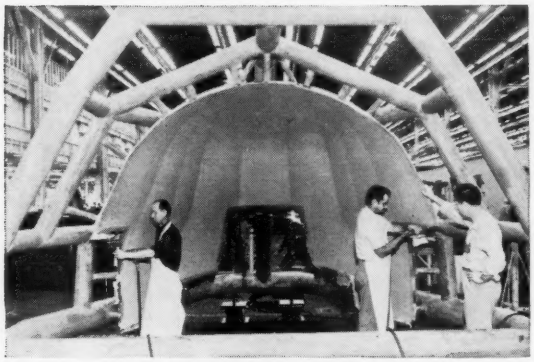
1 The tube is a reinforced epoxy housing that protects:
(a) a communications antenna *(b) a radio transmitter*
(c) miniature rockets

2 Its ignition coil, completely embedded in epoxy, is safe from:
(a) moisture *(b) temperature extremes*
(c) shock

Can you pass this test on Epoxy Plastics?

(You'll profit by knowing them better)



3 This airplane construction tool of epoxy-glass cloth:
(a) checks dimensions of fuselage *(b) supports the frame*
(c) is part of the mock-up

4 This tough, strong, pleasure boat hull is made from:
(a) laminated epoxy and glass fiber *(b) epoxy-coated wood*
(c) epoxy-coated metal

5 Their trip to school is safer in a bus with:
(a) epoxy-glass fiber seat frames *(b) an epoxy-sand coated floor*
(c) epoxy-embedded electrical parts

ANSWERS... *to tomorrow's needs are coming from adaptable BAKELITE epoxy plastics.*

1. Check (a). It minimizes weather and electrical interference along our defense communications lines.
2. Pick (a), (b), and (c)—and epoxy won't harm delicate windings, either.
3. (a) Checks dimensions—it's lightweight and extremely accurate.
4. (a) Epoxy-glass laminate—but epoxy coatings are great on other hulls.
5. (b) They won't slip on this floor's tough, gritty surface.

If you have questions— about epoxies and their potential for your business—please ask us. Why not discuss the matter with a Bakelite Technical Representative? Just write or call any of our offices, or write *UNION CARBIDE CANADA LIMITED, BAKELITE DIVISION, 123 Eglinton Avenue E., Toronto 12, Canada*

BAKELITE DIVISION

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STAN STEEL TUBING

New advancements—new improvements in your products are limited only by the boundaries of creative imagination. You'll find that versatile welded steel tubing, fabricated for you by Standard Tube, can solve your design problems.

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Aluminum Sheet, Bar, Extrusions, Tube and Wire also available in any quantity.

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VICKERS Hydraulics and Alternating Current keep capital investment low • speed cargo handling

Take advantage of Vickers hydraulics when you design or build a vessel. It offers the *infinitely variable speed control* needed for cargo handling *plus* savings that result when AC current is used exclusively on a vessel.

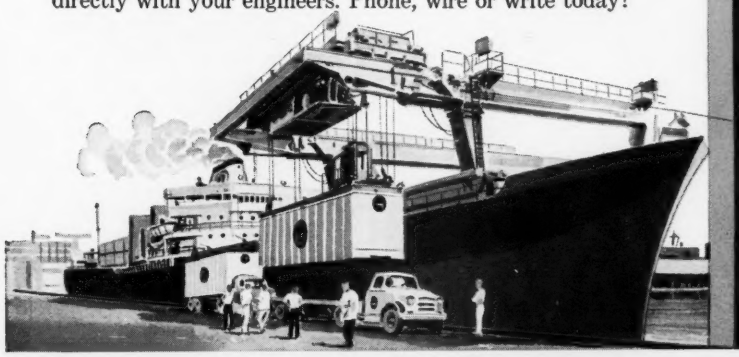
Hydraulics reduces electrical investment — With hydraulics and an all AC system, generators are simpler and less expensive. Dual generator systems, complicated switchboards and switch gear are automatically eliminated. Less wiring is required. Motors, appliances — even lamp bulbs — cost less.

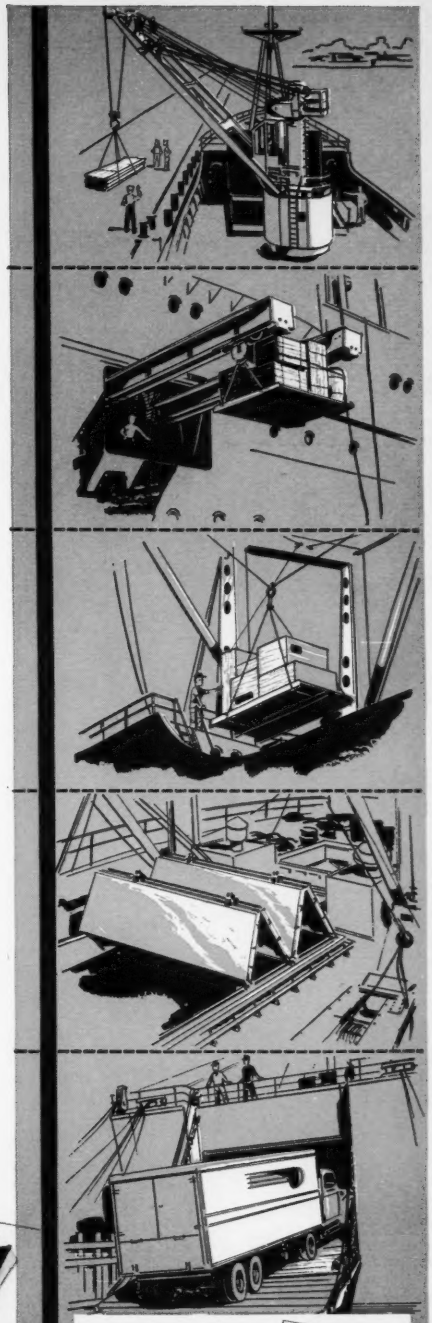
Hydraulics speeds cargo handling — Users have proved that more cargo can be moved per watch with hydraulically powered handling equipment. The reason? Acceleration and deceleration is faster, smoother than any other drive. Reversal is virtually instantaneous. Infinitely variable speed control is an inherent characteristic of these drives.

Hydraulics improves space utilization — Per unit of bulk or weight, hydraulic units give *more power* than any other drive. Thus, cargo-handling equipment can be extremely compact. Furthermore, the valuable below-deck space required for operation of old style variable speed devices can be released for cargo.

Hydraulics permits design flexibility — Hydraulic motor (or pump) can be mounted in any plane. Shafts can be horizontal, vertical or at any angle. Pumps can be located remotely. Steel tubing between units is run like cable — around corners or through bulkheads.

Vickers has engineered hydraulic systems for practically all of the modern cargo-handling devices from conventional winches to "lift on-lift off" gantries. This experience is available to you. A team of hydraulic specialists is "on call" to work directly with your engineers. Phone, wire or write today!





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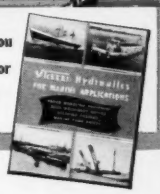

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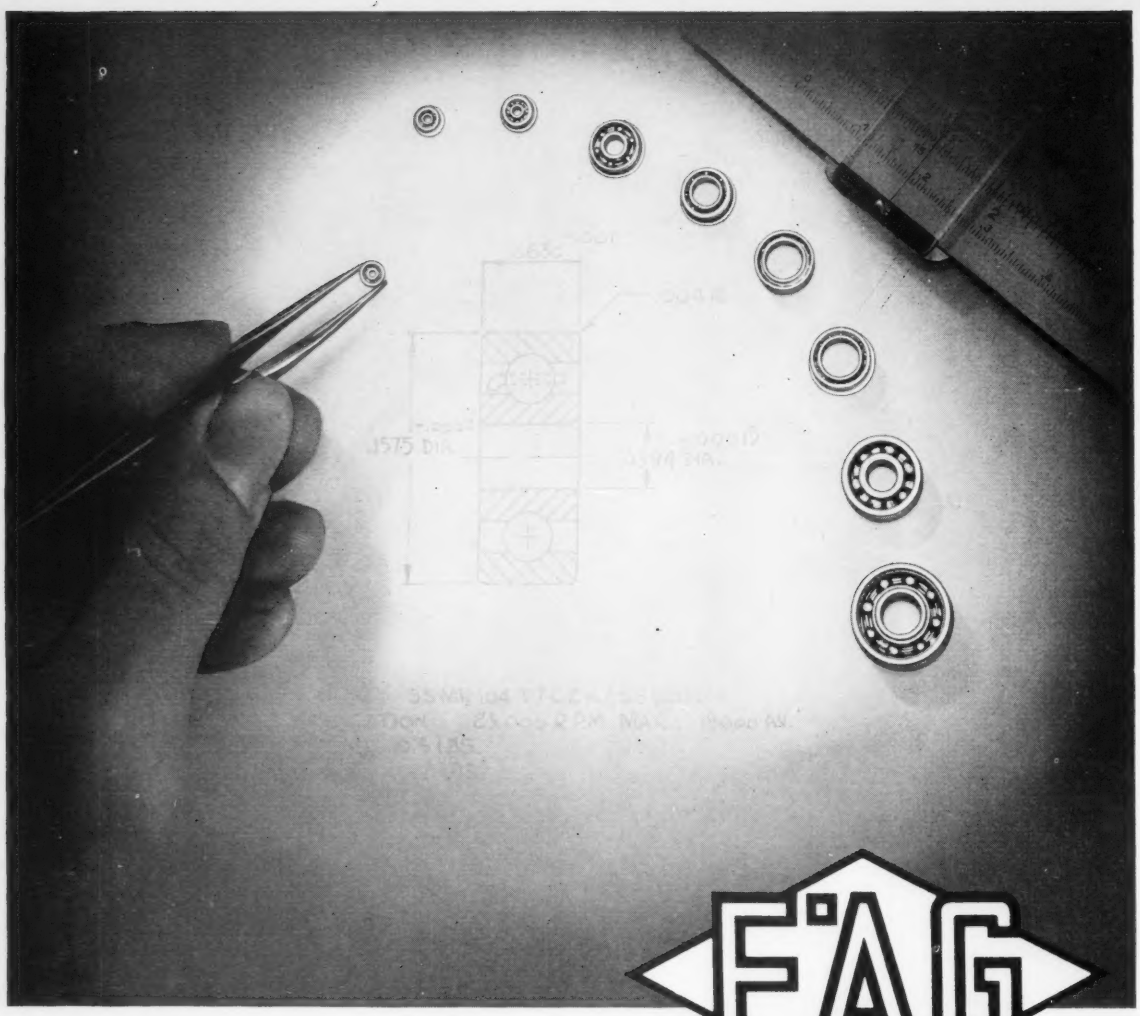

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ULTRA-HIGH PRECISION INSTRUMENT BEARINGS

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The accumulated skill and technological progress derived from 75 years experience since Fischer first founded the world's ball and ball bearing industries, are now embodied in each F*AG Ultra-high precision instrument bearing. Ranging in size, from as small as 0.1000 inch in outer diameter, these bearings incorporate the latest design principles to meet the most stringent demands imposed by the ever growing Aircraft and Electronic industries in Canada today.

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Fischer Bearings (Canada) Limited, 172 Lakeshore Blvd. East, Toronto, Ont. (Phone EM. 4-5307)
and Fischer Bearings (Canada) Limited, 6546 Upper Lachine Rd., Montreal 28, Que. (Phone HU. 1-7760)

H 7001

For further information mark No. 137 on Readers' Service Card

Victor sealing development news

New Aluminum Precote Process Insures Positive Gasket Performance

Exclusive Victor Aluminum Precote speeds heat transfer . . . provides higher temperature resistance . . . compensates for irregularities of mating surfaces . . . eliminates need of supplementary gasket cement

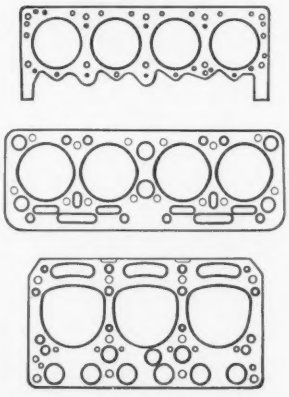
This newly developed Aluminum Precote provides simplified gasket installation and insures positive performance on high-temperature engine applications.

Deficiencies in earlier gaskets of this type have been completely eliminated by a new and thoroughly tested aluminum pigmented organic coating, and by refinement of the application method.

New Advantages

- The new processing method permits application of coating to finished gaskets, ready for shipment when coated, thus eliminating possible handling damage.

Available Gasket Types and Uses



Improved Aluminum Precote is performing successfully on beaded steel, metal-and-asbestos, metal core, and other gaskets suitable for engine head, manifold, transmission, and similar high-temperature, heavy-duty installations.

- Improved coating formula and new application method permit a heavier and completely uniform film on both gasket faces, in controlled thickness from .00075 to .0015 in.

- Controlled baking of coated gaskets at 400 deg. F. gives notably increased resistance to high working temperatures. Precote adhesion to gasket surfaces is improved.

- Resistance to gasket corrosion on contact with antifreeze and coolants is greater—with reduced possibility of blow-by between combustion chamber openings of gaskets.

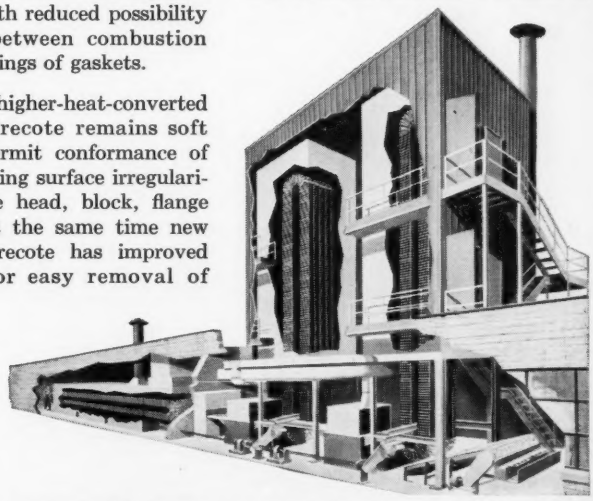
- The new, higher-heat-converted Aluminum Precote remains soft enough to permit conformance of gasket to mating surface irregularities of engine head, block, flange faces, etc. At the same time new Aluminum Precote has improved properties for easy removal of gaskets.

For your test purposes Victor will apply—at no charge—this new Aluminum Precote to two or more pieces on any Victor head gasket you are currently using. This service—or your inquiry for complete technical data and prices—involves no obligation. Handle through your Victor Field Engineer or direct with the factory. See address below.

SAMPLES FREE... ON YOUR OWN GASKETS

New and Improved Facilities Allow High-Capacity Production

Three stories tall, and based on automated conveyor system operation, this Victor installation chemically prepares incoming gaskets, applies and bakes-on Aluminum Precote in one continuous pass. This exclusive system improves the product and gives Victor much-enlarged production capacity.



Victor Mfg. & Gasket Co. of Canada Ltd., St. Thomas, Ontario—In the U. S.: Victor Mfg. & Gasket Co., Chicago 90, Illinois.

VICTOR GASKETS

World's leader in gasket design and development for automotive and industrial application

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A GeMex APPLICATION

INDUSTRIAL TOTE BOXES

For greater ECONOMY AND EFFICIENCY IN material handling operations

Since the dawn of civilization, man has used baskets and boxes to tote and carry his many possessions.

Now at last, a new man-made material provides for a really efficient product.

The New GeMex Tote Boxes specially designed for easy carrying, solid stacking and nesting can increase the efficiency of your material handling operations.

Stronger, lighter, and requiring no maintenance, GeMex Tote Boxes are lower in cost, and yet are practically indestructible.

Descriptive literature and sample of the material are available on request . . .

plastic experts for over 50 years

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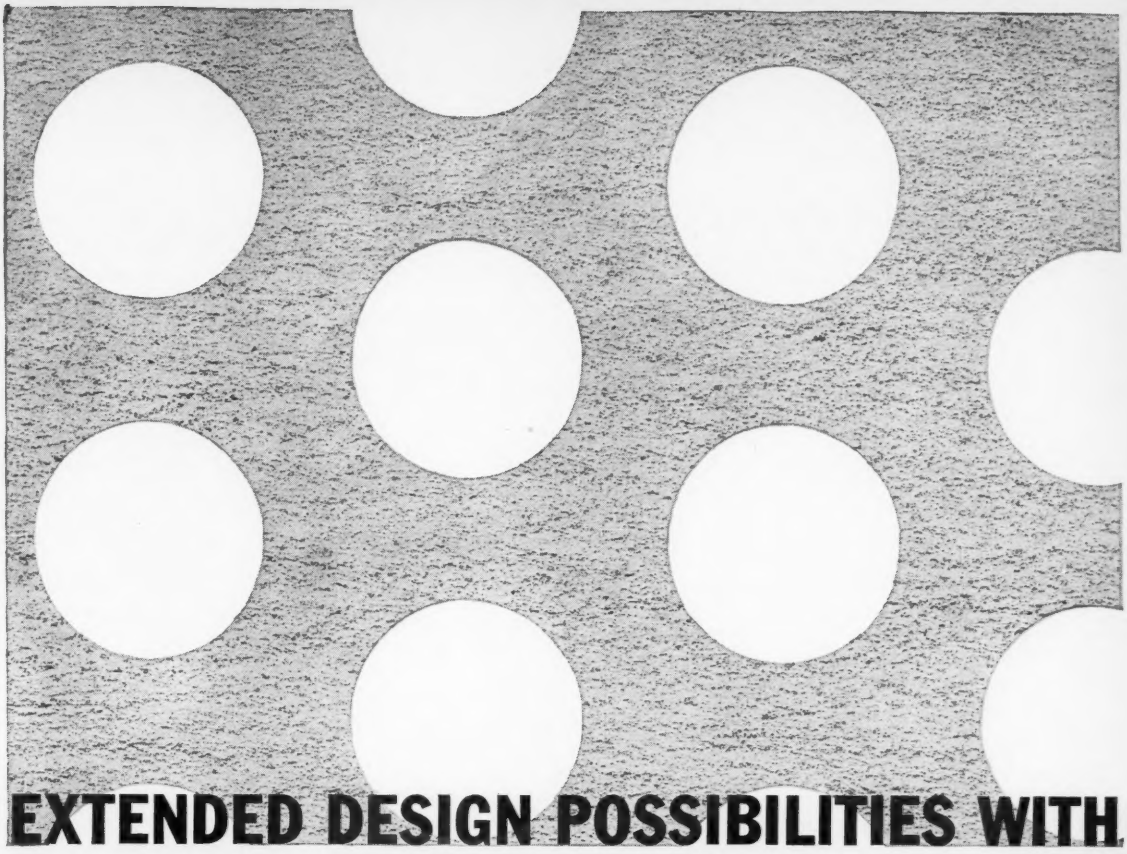

EXTENDED DESIGN POSSIBILITIES WITH DONALD PERFORATED METALS

Today's designers have constantly expanding scope, thanks to the increasing varieties of perforation patterns and perforated materials available from Donald's.

If you did not receive a copy of our catalogue, we would be happy to send you one.

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ROPES & WIRE CLOTH LIMITED
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Other offices and warehouses in Montreal, Winnipeg, Regina, Edmonton and Vancouver.
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D79R

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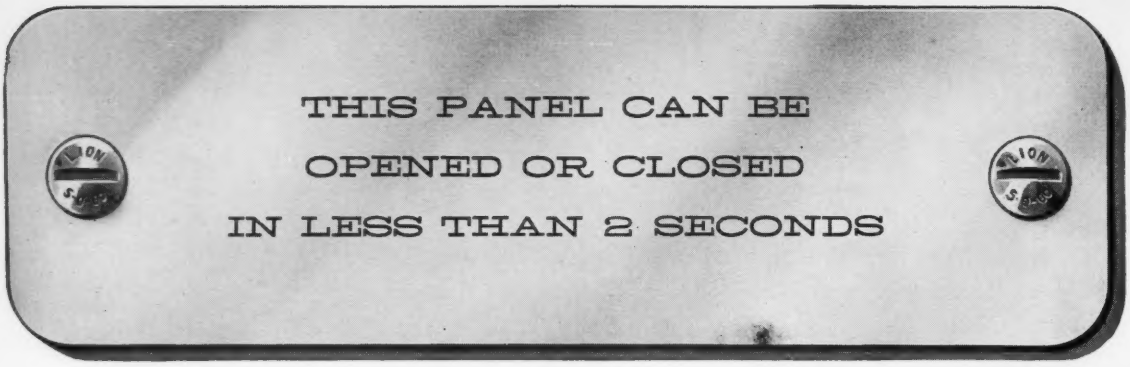
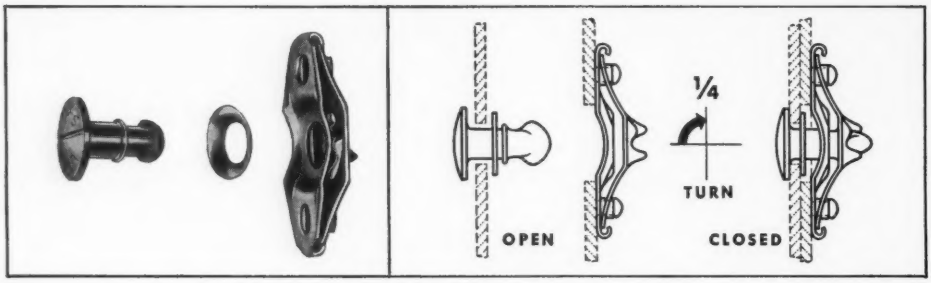


LION ¼ TURN OPEN ¼ TURN CLOSED FASTENERS

ARE FAST, POSITIVE, RELIABLE



Installation of the three parts of the Lion Fastener, shown above, is quick but not critical. Unique in design and performance, these mil spec (MIL-F 5591A-ASG) fasteners make possible quick access and smooth positive locking by only a ¼ turn.

ALIGNMENT NOT CRITICAL

Both stud and receptacle "float" to accommodate misalignment. The hole, which retains the stud, is twice as large as the stud cross-section. This permits a float of .070 in all directions. The leaf spring receptacle also floats to accommodate stud position.

WIDE VARIATIONS IN STACK HEIGHT

Total sheet thickness may vary as much as +.035 and −.015 without affecting operation. A Lion stud, specified for .160 total thickness, for example, will accommodate any stack height between .195 and .145.

SWAGED-NOSE STUD

Extra strength and smooth operation are made possible by the swaged-nose design. All the metal in the stud goes to work. There are no thin cross pins, holes or milled slots to weaken the cross-section. Case hardening is further assurance of long, trouble-free service.

WIDE VARIETY

Lion Fasteners are available in 3 sizes—No. 5, No. 2, and Miniature. An assortment of head styles are supplied—oval, flush, wing, ring, notched or knurled—according to individual requirements.

FREE!

FASTENER HANDBOOK

Send for your free copy of Southco Fastener Handbook No. 9. Gives complete engineering data on Lion Fasteners and other special fasteners.

Write to your nearest distributor listed below.

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one of the SOUTHCO LION FASTENERS

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380 Donald Street
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F.R.P.

FIBERGLAS REINFORCED PLASTICS

When you cut manufacturing costs, shipping costs *and at the same time improve the product* this makes business sense. And this is why more and more manufacturers are using F.R.P. today. With a strength-weight ratio greater than *any other known material*, F.R.P. makes it possible to fabricate lightweight articles of amazing strength and durability. To find out more about F.R.P. simply get in touch with any of the offices of

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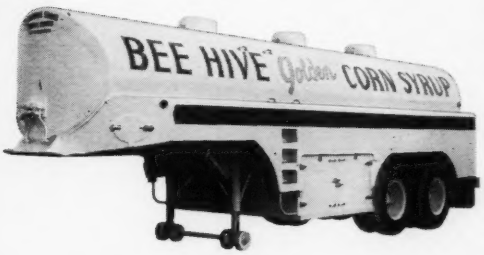
case history of the month



F.R.P. TANK TRUCK
built by Canbar Industrial Plastics saves weight, cuts hauling costs

It's elementary. If you want to cut hauling costs, cut weight. The greater the weight, the higher your fuel costs, the greater the wear and tear on equipment and moving parts.

How about a tank truck made entirely of FIBERGLAS REINFORCED PLASTIC? So much lighter than metal that you can carry a greater live load at less cost per load. That's why St. Lawrence Starch Company hauls glucose in tank trucks made entirely of FIBERGLAS REINFORCED PLASTIC.

Built by Canbar Industrial Plastics Division of Canada Barrels and Kegs Limited, Waterloo, Ontario, in conjunction with Brantford Coach & Body Ltd., the total weight of the truck is only 10,700 lbs. and it has a capacity of 2,750 gallons in 3 bulk head compartments. A metal truck of the same capacity would weigh approximately 16,000 lbs.

**T.M. Reg'd.*

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COLD HEADED TO CUT COSTLY MACHINING... *and to provide greater strength!*

When a part is cold headed, rather than machined from bar stock, the saving in material is immediately evident and may reach as much as 60%.

Although varying with the individual design, cold heading production rates are always faster than machining rates for similar pieces, and the process offers the further advantage of increasing the tensile strength and toughness of the material, and the durability of the finished part.

Wire up to 1" in diameter, of any forgeable metal, can be upset to at least 4½ times its original diameter. Secondary operations such as flattening, bending, threading and punching can be added. Let Stelco's Engineers advise if parts you are now machining can be produced more profitably by cold heading.

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Meet a specialist...

He's a Dominion Fasteners sales engineer, and he specializes in saving Canadian manufacturers *time* and *money*. Thoroughly trained and experienced in all fastening procedures, he can quickly analyze your product, showing you where Speed Nuts can cut product assembly time, lower production cost, and actually improve your product.

There are over 8,000 different sizes and types of Speed Nuts in use today. One of these will probably be suitable for your operation. If not, the designers at Dominion Fasteners can develop a fastener to meet your specific requirements.

Because you're a manufacturing "specialist", you'll want the complete story about Speed Nuts and savings.

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HAMILTON, ONT. Sales Branches: Toronto, Montreal
a Geo. A. Tinnerman corporation

Rush me complete information on how Speed Nuts can save me time and money, and make my product more competitive.

NAME_____

COMPANY_____

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WE MANUFACTURE_____

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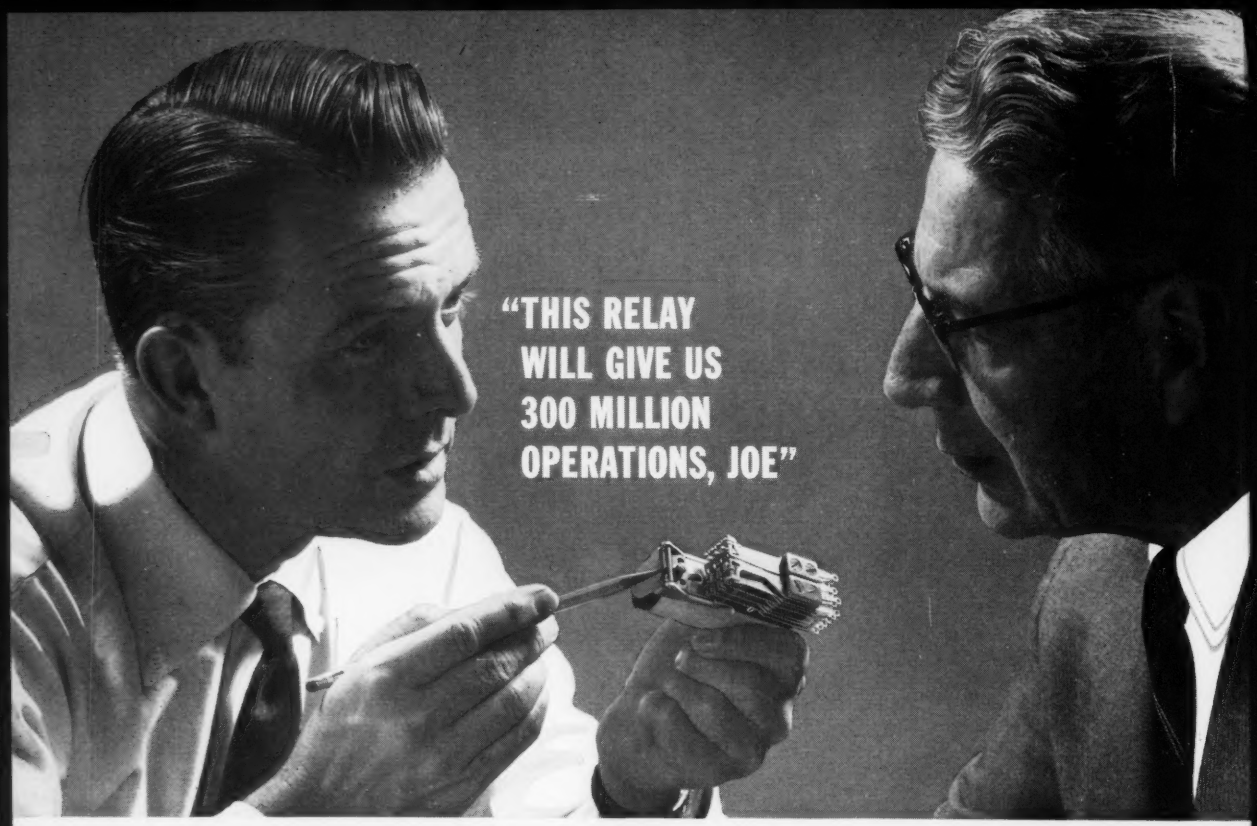
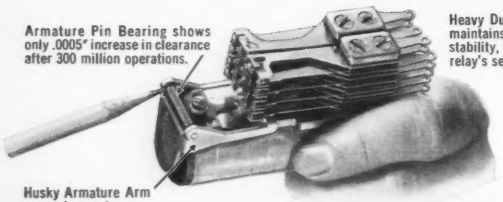


HERE'S WHY P&B TELEPHONE TYPE RELAYS GIVE YOU

reliable performance over long life


Armature Pin Bearing shows only .0005" increase in clearance after 300 million operations.
Heavy Duty Frame maintains dimensional stability, adds to relay's sensitivity.
Husky Armature Arm prevents sagging or bending.

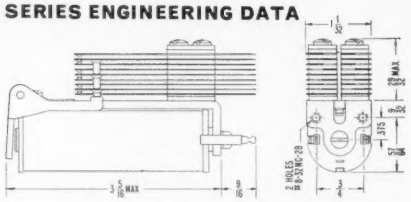
BS SERIES TELEPHONE TYPE

Measure the thickness of the BS series armature arm. You will find the cross section area is greater than ordinary relays of this type. Here is the kind of quality that spells dependability.

Observe that the stainless steel hinge pin runs the full width (not just half) of the armature, providing optimum bearing surface. This pin, operating in a stainless steel sleeve, shows only minimal wear during nearly a *third of a billion operations.*

Best of all, P&B quality costs no more. A whole new plant is being devoted to the production of high performance telephone type relays. Your nearest P&B sales engineer will be happy to discuss your relay problems. Call him today.

BS SERIES ENGINEERING DATA



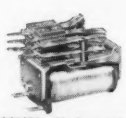
GENERAL:
Breakdown Voltage: 1000 volts rms 60 cy. min. between all elements.
Ambient Temperature: −55° to +85° C. +125° C available on special order.
Weight: 9 to 16 ozs.
Terminals: Pierced solder lugs; Coil: One #16 AWG wire Contacts: Two #18 AWG wires
Enclosures: Dust covered or sealed

CONTACTS:
Arrangements: DC—up to 28 springs AC—up to 24 springs
Material: 1/16" dia. twin palladium. Up to 1/4" dia. single silver. Other materials on special order.
Load: 4 amps at 115 volts, 60 cycle resistive
Pressure: 15 grams minimum

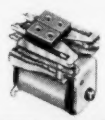
COILS:
Resistance: 100,000 ohms maximum
Current: 10 amps maximum
Power: DC—50 Milliwatts per movable arm. Greater sensitivity on special order. AC—17.9 volt-amps.
Duty: Continuous
Treatment: Centrifugal impregnation
Voltages: DC—up to 300 volts with series resistor. AC—up to 250 volts, 60 cy.

MOUNTING: Two #8-32 tapped holes 3/4" o.c. Other mountings on special order.

GS SERIES—Excellent sensitivity: 50 mw per movable arm minimum (DC). For applications requiring many switching elements in small space.



LS SERIES—Medium coil relay with short springs and light weight armature for fast action, reliability and long life.



TS SERIES—Short coil relay is available in AC and DC versions. Long life construction. Can be supplied (DC) with up to 20 springs (10 per stack).

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD CANADA LTD.

GUELPH, ONTARIO

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the standard of machineability

Noranda Free Turning Brass Rod permits a production flow of thousands of parts at uniform tolerances and minimum tool wear. This free-cutting alloy with a machineability rating of 100, fills all the industry's needs for machining rod. Noranda Free Turning Brass Rod is made in a wide range of standard and special shapes to meet broad or specialized production needs. Call your nearest Noranda Sales Office, we will be glad to help you with information and technical service to achieve quality in volume at competitive costs.

THE KEY TO THE BEST IN METALS

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one coat finish

DURACRON*

*T.M. reg.

Thermo-setting Acrylic Enamel

Duracron can be applied by a variety of high-speed methods. Its fast set reduces rejects and its hardness lessens the danger of marring in assembly.

Duracron, the unique thermo-setting acrylic enamel, introduced less than two years ago, has been found to outperform any other chemical coating in a number of important applications where the best, and often the most economical, is required. Today and tomorrow where the trend is toward pre-coated and coiled sheet steel, galvanized, or aluminum strip, no other coating affords the toughness, flexibility, and durability of Duracron. In appliance finishes, or in fact for almost any product requiring a one coat baking enamel, Duracron excels in colour retention, flexibility, adhesion, stain and chemical resistance, and in all around performance. Savings in finishing costs will surprise you.

Contact your nearest C.P.I. sales office in Montreal, Toronto, Winnipeg or Vancouver.

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CHEMICAL COATINGS • DITZLER AUTO FINISHES • PLASTICS

Here are some of C.P.I.'s staff of laboratory specialists (lined up in a family photo) whose job is to develop and test a wide variety of chemical coatings for industry. They are ready to work for you on your next coating problem.

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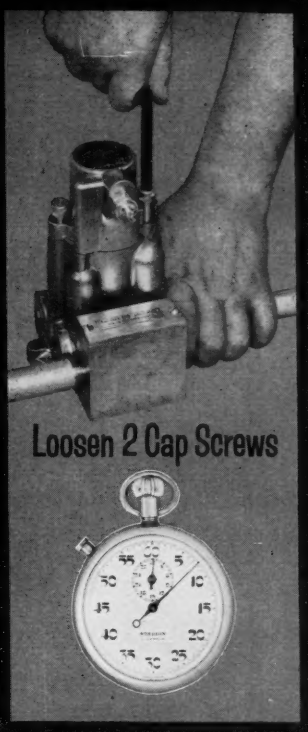
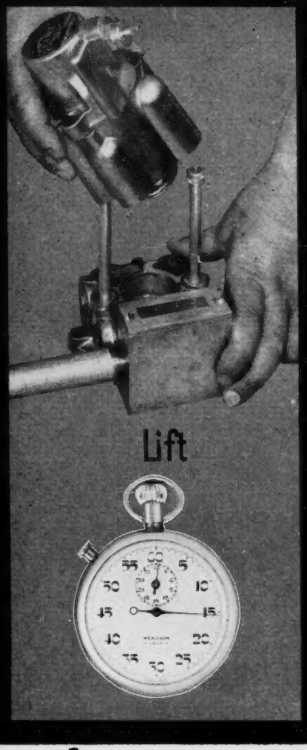
ONE MAN ONE TRADE ONE TOOL

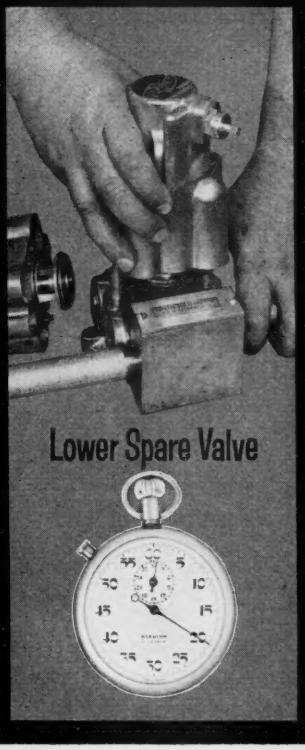
...your production line back in operation in

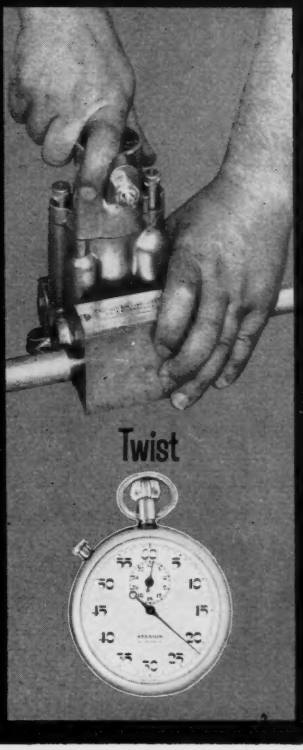
30 SECONDS

(if it's a Hunt PDQ Air Control Valve)









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Quick-As-Wink AIR & HYDRAULIC CONTROL VALVES

Veeder-Root READOUT Bulletin

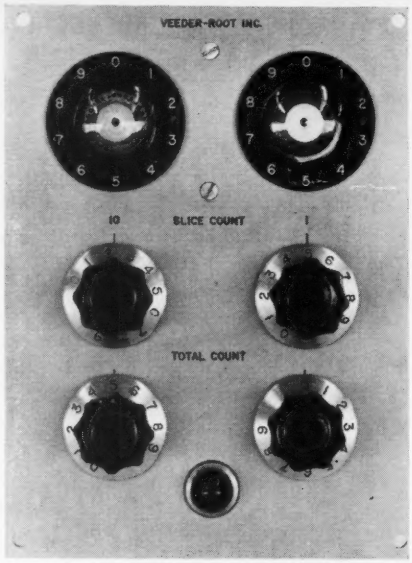
New Electronic Counters provide simplified operation, automatic control for Original Equipment

Veeder-Root Electronic Predetermining Counters are now being used to improve machine efficiency by providing varying degrees of automatic control as original equipment.

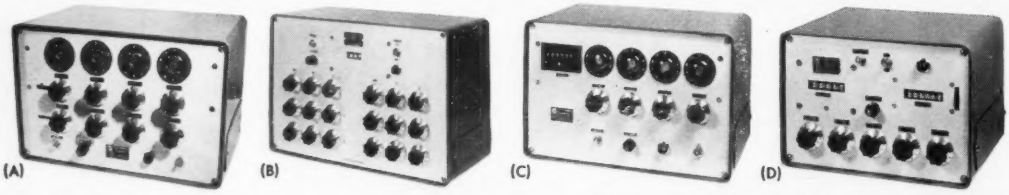
These new electronic counters count electrical impulses. This makes them extremely versatile — and suited to design innovation — because these pulses can be supplied by photoheads, snap-action switches, mechanical contactors, impact and proximity switches, and the like. Photohead actuation alone has almost limitless application potential, and is ideal for high velocity, non-contact counting at any stage of a machine's operation.

The predetermining action — which actuates machine controls, signals, etc., — can run the extreme from a single stop motion, with only one bank of selector knobs all the way to multiple banks which are used to set up a series of stop motions, usually sequentially. There is no theoretical limit on the number of banks (or sequential stops) that can be provided. Counting speeds are available up to 5000 counts per second, and even higher in special applications. Instantaneous reset and automatic recycling are also valuable features.

Some of the many possible counter variations are shown below. Both the 1804 Series, Electronic, and 1601 Series, Electric, Counters are providing this type of control as original equipment on a variety of machines, from bacon slicers to plastic film extruding machines. Design and engineering assistance is available to help achieve maximum operating efficiency for your equipment.

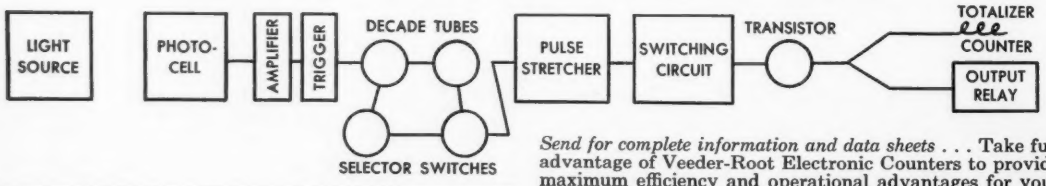


This is a panel mounted Series 1804 Predetermining Counter designed to control operation of a bacon slicing machine. Top bank of knobs is preset to number of slices in each package, other set controls total number of units or packages.



These are a few of the variations in predetermining control available with the Veeder-Root Series 1601 Electric and 1804 Electronic Counters. **(A)** For measuring film footage; when number on top set of dials is reached machine is slowed down, then stops when lower number is reached. **(B)** Series 1601 Counter, designed for sequential control based on six preset quantities. **(C)** A four figure counter incorporating a batch totalizer. **(D)** Series 1601 Counter with five figures, one set of preset numbers and a totalizer for counting cycles or batches.

Simplified Schematic of the Veeder-Root Series 1804 Electronic Counter



Send for complete information and data sheets . . . Take full advantage of Veeder-Root Electronic Counters to provide maximum efficiency and operational advantages for your equipment. Contact your nearest Veeder-Root Counting Engineer, or write direct.

Veeder-Root Electronic Counters are designed to your specific requirements. These are some of the many operations now being performed with this modern control method.

measuring	batching mixes	packaging rolls
bin loading	can counting	coil winding
pill packaging	bread slicing	labeling machines
tube cut off	cap counting	nail packaging
bag counting	flow measurement	conveyor control
tool control	predetermining revolutions	

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VRO-24

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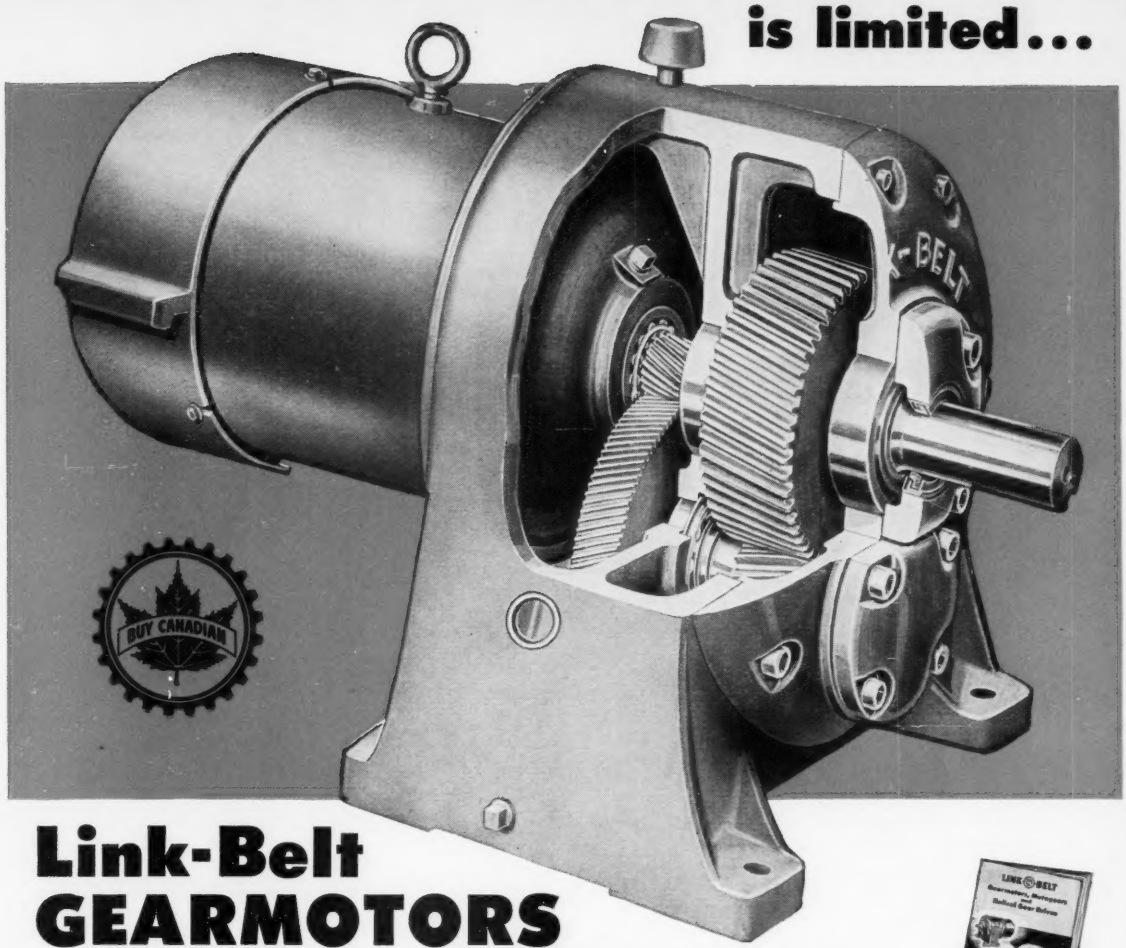
Efficient speed reduction where space is limited...



Link-Belt GEARMOTORS

With their integrally-mounted CEMA electric motors, Link-Belt Gearmotors are your economical answer to efficient speed reduction in minimum space. And to assure years of trouble-free service, they're built better these ways:

BUILT-IN ALIGNMENT of motors and gears results in lasting efficiency plus maximum safety. **HOBBED HELICAL GEARS** are rigidly mounted for smooth, quiet action. Pinions are heat-treated chrome-moly steel.

SHAFTS are precision machined and ground. **ANTI-FRICTION BEARINGS** withstand heavy loads.

AUTOMATIC SPLASH LUBRICATION system reliably supplies oil to all moving parts. **MAGNETIC DRAIN PLUG** removes ferrous particles from lubricant.

BUILT-IN POSITIVE BACK-STOP is available on all units.

LINK-BELT GEARMOTORS are designed to meet the most demanding operating conditions. And they're stocked in various horsepowers and ratios for immediate shipment from your nearest Link-Belt factory branch store. For details, contact your representative.

FOR MORE FACTS ON GEARMOTORS WRITE FOR BOOK 2247

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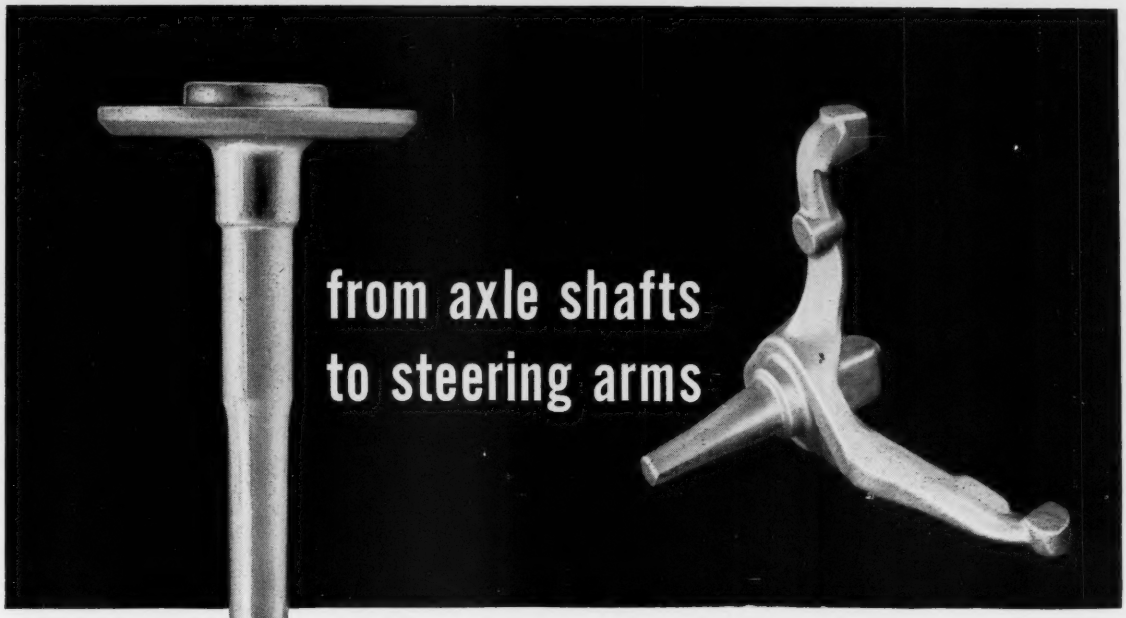

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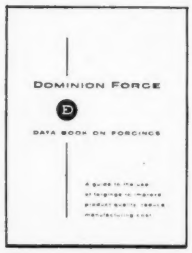

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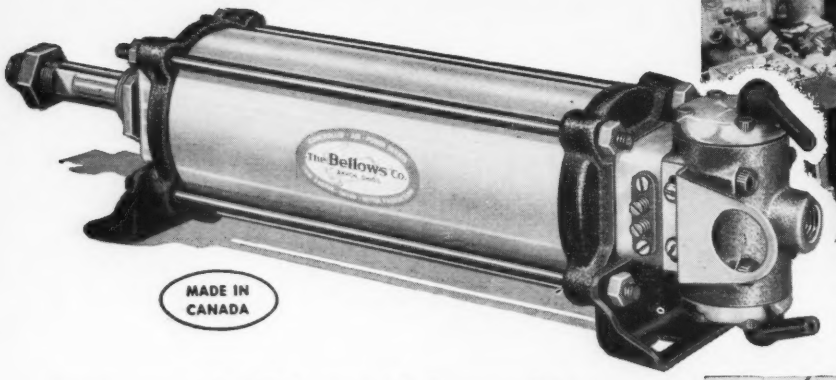

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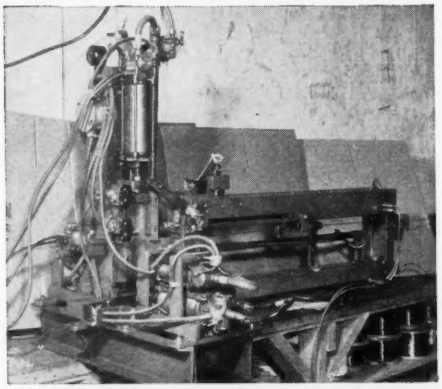

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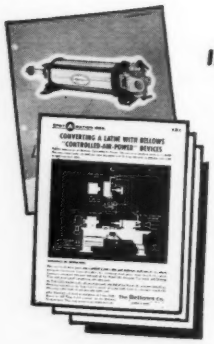

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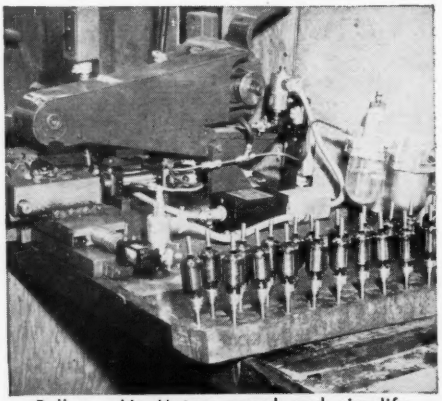

Bellows Air Motors speed and simplify polishing stainless steel "buttons" on electric motors for home appliances on this special machine at Sunbeam Corp. (Canada) Ltd., Toronto.

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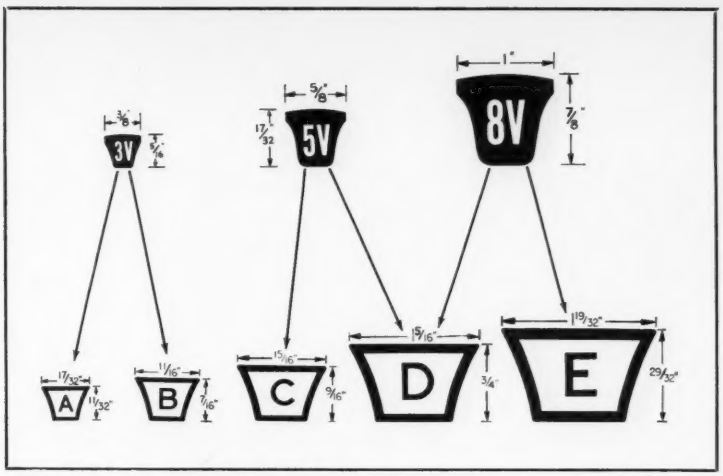


1. Comparison of the old and new in V belts.

New concept in V-belt power transmission

More power in less space, no sacrifice of belt life

G. C. Fair
General Sales Manager
Gates Rubber of Canada Ltd.

Improvements in engineering components are always news to the designer. A component that permits greater power while occupying less space is particularly welcome. Here then are the facts you should know about the high capacity V-belts introduced some months ago.

Is there a design engineer today who hasn't been confronted with the demand —"Get more power—use less space"? Chances are that such demands have been experienced by every engineer in design work during the last twenty years. To meet these demands, mechanical power transmission engineers in the V-belt industry years ago embarked on an intensive research and application program.

Prior to World War 2, the major reinforcing member for rubber was cotton; rayon had just entered this field, but with relatively little knowledge existing as to its actual value as a reinforcing member for rubber. Nylon too, was in its infancy, and though it possessed many desirable physical properties, such as high tensile strength, resilience etc., little was known as to its value as a reinforcing member for rubber. In addition, many synthetic rubbers such as Buna S, Buna N, Neoprene, Butyl, Thiokol and others, were developed and improved during the War, and their value and place in industrial rubber products were still to be determined. The research task that lay ahead of the rubber chemist, the textile engineers and the V-belt engineers during this period was a challenging one.

In the late 20's the V-belt industry established the common designation of A-B-C-D-E, to identify the standard cross sections of industrial V-belts. (fig. 1.) The industry later established the recommended range of small sheave diameters, over which each belt cross-section should operate. (Table 2.) These diameters closely paralleled the then existing NEMA standards for

continued

pulley diameters and face widths, and are still in use today, for standard belt cross-sections. Table 3 suggests the variance existing between today's motor standards and those of the V-belt industry, as applied to standard cross-section V-belts.

The development of the narrow, "High-Capacity" fan belt, first used in 1947, was the first break-through in giving "more power in less space". This development resulted in using smaller diameters, less face width on sheaves, and yet delivered more power with greater life than previous style fan belts. Through the use of new fibres and synthetic rubber, tensile strength, flex life, oil and heat resistance were greatly improved, with a resultant higher belt life and drive compactness. Yet to be determined however, was whether this development could be successfully applied to multiple-strand drives.

H-C belts deliver more power

After exhaustive study and research announcement of the development of a new concept in multiple V-belt power transmission, was made jointly in December 1958 by Gates Rubber Co. and Dodge Manufacturing Co. The significance of this announcement was not in the fact added power was being built into V-belts, but that completely new cross-sections, three in number, would now cover a wider range of applications, than the existing five cross-sections (fig. 2). It was similarly announced that only two cross-sections in sheaves would be considered as standard, with a third cross-section, the "8V", being available on a made to order basis.

These new Super H-C belt cross-sections and their corresponding Super H-C sheaves opened entirely new areas of V-belt applications. Several examples of the rated horsepower capacity of the Super H-C V-belts at minimum diameters, and with a 1:1 ratio, compared to their standard cross-section equivalent,and their minimum diameters are shown in Table 1.

new applications open up for V-belts

The diameters shown for the various H-C cross-sections are those diameters which approximate the current minimum recommended diameters for electric motors, as published in NEMA Standard MG 1-3.16 and MG 1-3.16A. The diameters shown under the standard cross-sections "A", "B", "C" etc., are the minimum recommended diameters for each belt cross-section as established by the Rubber Manufacturer's Association. For a given motor hp and motor speed there is a recommended range of small diameters for each the "3V" and "5V" cross-sections. To stay within these ranges the design engineer will be well within motor manufacturer's standards.

This development has been made possible only through the development of better elastomers and textile reinforcing members. The use of any V-belt over diameters smaller than the recommended minimum diameter for that belt causes frequent belt replacement, with resultant high replacement costs. The reason for this is mainly due to the high stress level introduced into the belt. A belt is sometimes called upon to undergo over a *billion* stress cycles

design specs for the old and the new

TABLE 1

"3V" Section	**"A" Section Std.**	**"3V" Section**	**"B" Section Std.**
2.65″ O.D.	3.0″ P.D.	4.75″ O.D.	5.4″ P.D.
1750 R.P.M.	1750 R.P.M.	1750 R.P.M.	1750 R.P.M.
1.55 H.P.	.82 H.P.	4.42 H.P.	2.97 H.P.
"5V" Section	**"C" Section Std.**	**"5V" Section**	**"D" Section Std.**
7.1″ O.D.	9.0″ P.D.	12.5″ O.D.	13.0″ P.D.
1750 R.P.M.	1750 R.P.M.	1160 R.P.M.	1160 R.P.M.
11.8 H.P.	7.9 H.P.	19.2 H.P.	13.8 H.P.
"8V" Section	**"E" Section Std.**	**"8V" Section**	**"E" Section Std.**
18.0″ O.D.	21.6″ P.D.	18.0″ O.D.	21.6″ P.D.
870 R.P.M.	870 R.P.M.	690 R.P.M.	690 R.P.M.
40.5 H.P.	29.8 H.P.	34.8 H.P.	29.5 H.P.

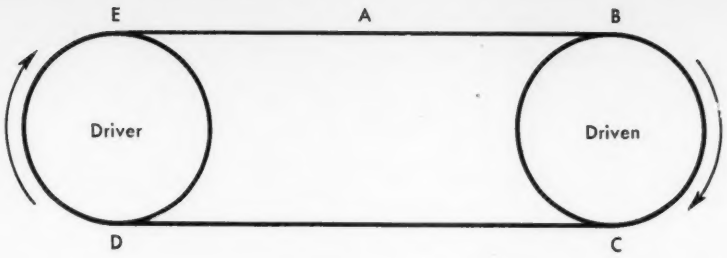


TABLE 2

	A	B	C	D	E
	Pitch Diameter	Pitch Diameter	Pitch Diameter	Pitch Diameter	Pitch Diameter
Recommended Range of Small Sheave Pitch Diameters	3.0″	...	9.0″	....	....
	3.2″	...	9.2″	....	....
	3.4″	5.4″	9.4″	....	21.0″
	3.6″	5.6″	9.6″	13.0″	21.6″
	3.8″	5.8″	9.8″	13.5″	22.0″
	4.0″	6.0″	10.0″	14.0″	22.4″
	4.2″	6.2″	10.2″	14.5″	22.8″
	4.4″	6.4″	10.6″	15.0″	23.2″
	4.6″	6.6″	11.0″	15.5″	23.6″
	4.8″	6.8″	12.0″	16.0″	24.0″
	5.0″	7.4″	13.0″	18.0″	27.0″

recommended sheave diameters for standard belts

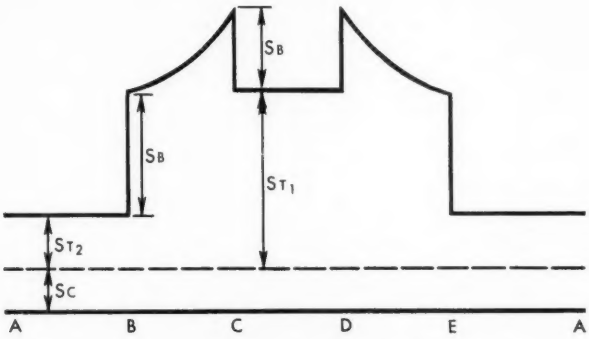
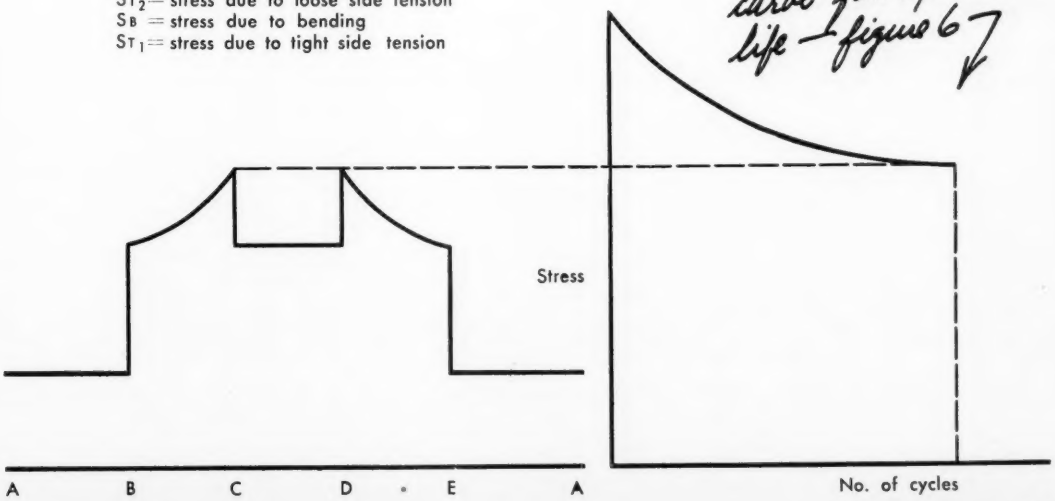


diagram of peaks in stress cycle — figure 5

S_C = stress due to centrifugal force
S_{T_2} = stress due to loose side tension
S_B = stress due to bending
S_{T_1} = stress due to tight side tension

adding the S-N curve for optimum life — figure 6



continued

before failure, and this can only be attained if the design engineer is aware of the fundamental basis of V-belt drive design.

Let us analyze the stresses that develop at a point in the tensile member of a V-belt, on a 1:1 ratio, as it makes a complete revolution.

let's analyse the stresses

The peaks in the stress cycle (fig 5) are used as the basis of predicting belt life. The higher the value of the peak stress, the fewer number of cycles will be required for the belt to reach fatigue. Through developing a S-N curve (stress-number of cycles) for a given belt construction, and projecting the "peak" stress value of the S-N curve, belt life can be determined (fig 6). Also to be considered however, is the belt length, belt speed, and number of sheaves over which the belt operates in one complete revolution.

The rated hp for a given belt then, is in effect, the stress level that the belt should be subjected to under its operating condition. This rated hp/belt must then be divided into the actual design hp in order to determine the number of belts required. This design procedure then places the stress level in all belts on the drive, at a point on the S-N curve, well in excess of 5x10" cycles, normally considered to be desirable belt life.

This design theory is the basis of the hp ratings for all types V-belts. The S-N curve is developed through enveloping the minimum points of the S-N curves for all the components within the belt. These components are the tensile member, adhesive gums, undercord, cover and others, depending on the nature of the belt construction. The S-N curve for the H-C belt follows a similar pattern to the S-N curve in Figure 5, except that this belt will withstand approximately twice the stress level for a given number of cycles than the standard rated belt.

Because of this S-N relationship, the application of the H-C belt to a given drive condition will permit the use of smaller diameter sheaves than its comparable standard cross-section. As noted in Figure 5, the magnitude of the bending stress determines the value of the peak stress for most drives. Because the H-C belt can withstand higher stress, it can successfully operate over smaller diameters without sacrificing belt life.

and what about tension?

The usual V-belt design tension ratio 7 $T_1/T_2=5$, (T_1=tight side tension, T_2=loose side tension) is also used in H-C belt design. It must be pointed out that the use of the H-C belt in drive design will not result in using fewer belts in all cases, when compared to the number of conventional cross-section belts required for the same driving conditions. Rather, the comparison must be based on face width, not the units of belts required. Staying within the recommended range of diameters for a given cross-section H-C belt will generally result in lower bearing loads because of the reduction in overhang.

As a result of smaller diameters, shorter centre distances are possible, making the H-C drive very compact. This further leads to a reduction in weight of the drive over that of conventional V-drives. Additional size and

NEMA versus RMA standards

TABLE 3

HP at 1750 RPM	Current NEMA Minimum Diameter	Current RMA Minimum Diameter and Typical Cross Section
1 - 3	2.5	3 O/A
5 - 7.5	3.0	5.4/B
15 - 25	4.5	5.4/B - 9 O/C
50	6.75	9 O/C
60	7.5	9 O/C - 13 O/D

weight savings are brought about through reducing the size of guards, machine housing, countershafts etc. The use of the H-C drive on the ink rolling machine illustrates the potential savings in size and weight. (See below.)

The H-C drive can operate at belt speeds up to 6,000 ft/min without dynamic balancing. This enables the design engineer, in many instances, to use higher rpm motors than would be possible with conventional V-belts, whose operating limit is 5,000 ft/min without dynamic balancing. This results in potential savings in motor costs.

operating speed is a critical factor

Super H-C sheave diameters are designated in outside diameter, rather than pitch diameter, as is the case with standard sheaves. No correction is normally required for H-C belts to convert from O.D. to belt P.D., since the pitch line of the Super H-C belt coincides with the sheave O.D. This also simplifies design procedure. The belts are also designated in terms of outside circumference. Standard sheave diameters and belt lengths for H-C drives have been reduced to less than half the number of sizes in use with conventional V-belts. This simplifies replacement stocking, and at the same time, does not materially affect the designer's ability to cover nearly all speed ratios and centre distance requirements without having to use non-standard size sheaves or belts.

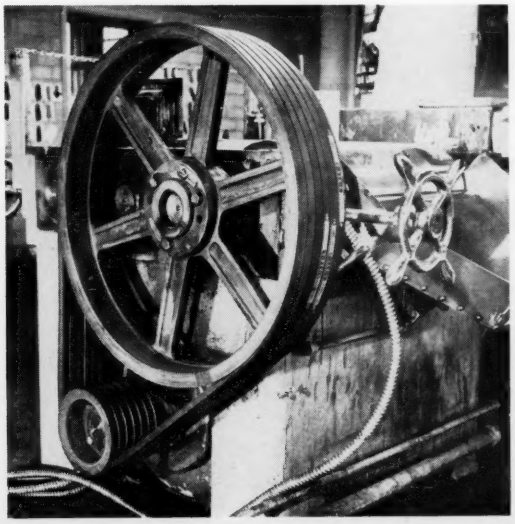
One of the main problems encountered by users of V-belts in multiple is the matching problem. The climatic stability of the H-C belt practically eliminates matching problems, since the belts stay matched while subjected to normal shelf life.

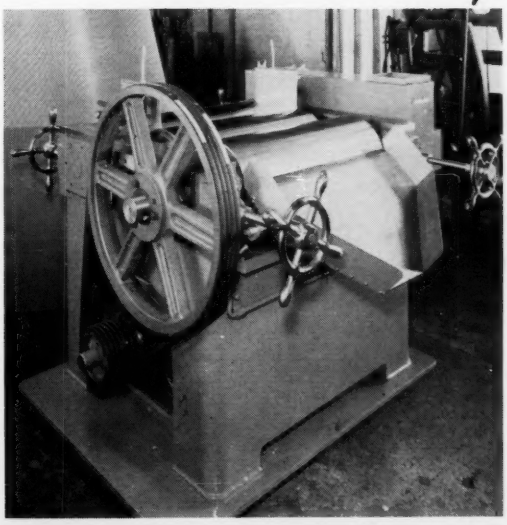
have trouble matching belts?

A drive using H-C belts requires no more over-all tension than any other V-belt drive of the same drive capacity. However, each belt in the drive will be tighter than a conventional belt operating on a similar drive. The H-C belt also operates within the same range of elongation as the conventional V-belt, which is approximately two percent of belt length. The rate of elongation is faster however than a belt of standard construction. It is therefore important that an H-C drive be retensioned at frequent intervals within the first 50 hours of operation. Beyond this point continued elongation will practically be nil.

Most V-belt manufacturers are now engaged in manufacturing these new cross-section belts, and within a few years, the conventional V-belts now in existence will become more difficult to procure. The economic advantages in this new concept of V-belt power transmission is shared by manufacturer, distributor, and end user. Continued research in materials and construction will undoubtedly bring about even greater improvements in the Super H-C belt. And since over 65 percent of the machines in industry are driven by V-belts, the demands for increased power capacity in even less space than is presently available necessitate the need for continued improvements for the V-belt of the future. ★

the old and new on inking machine





Design criteria for anti-friction bearings

Average life may be five times the rating life

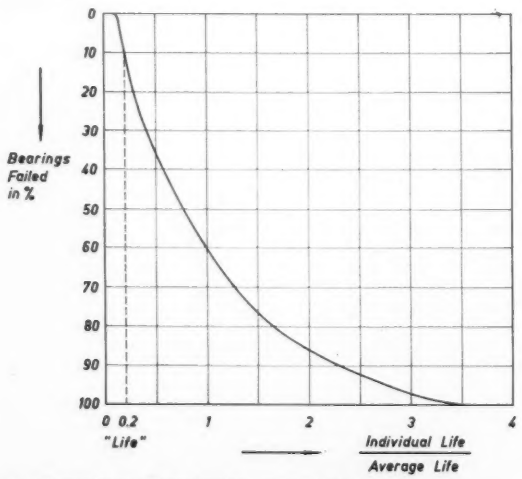
R. E. Leeming, P.Eng.
Chief Engineer
Fischer Bearings Mfg. Ltd.

Anti-friction bearing failures, and the need to replace the failed bearings, which may sometimes be a very costly item, often cause designers to ask "just how long may I expect a bearing to last?" That, indeed, is a very good question.

Bearing failure can normally be expected, and plans made in maintenance programs to take preventive measures through a routine replacement procedure. Premature failures, however, are a different matter.

Bearing life generally is agreed to be the amount of time which a bearing operates until the first evidence of fatigue. However, even bearings of the same size and type manifest marked differences in life spans. Indeed the life of the last bearing to fail may be 20 to 40 times that of the first bearing to fail.

It is therefore necessary to define a life value which the bearing consumer may universally employ as a reliable criterion in his selection of the optimum and most economical bearing design for his application. If this value is excessive, it is obvious that a larger proportion of the bearings would have failed prior to the chosen life value having been attained by a sufficient quantity of the bearings. Conversely, if the selected value is too small, the user would be influenced in procuring a larger and less economical bearing size. The accepted criterion is defined as the Rating Life.



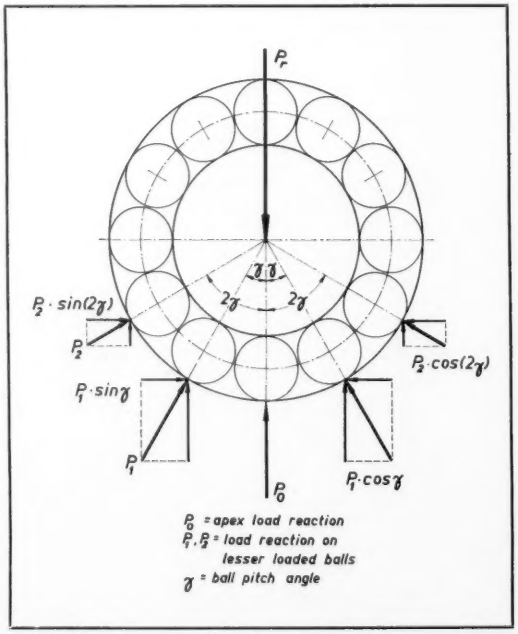
1. Cumulative distribution curve for bearing life.

The Rating Life of a group of apparently identical ball or roller bearings is defined as the number of revolutions (or hours), at some given constant speed, that 90% of a group of bearings will complete or exceed before the first evidence of fatigue.

From Figure 1 it may be seen that the average life is approximately 5 times the rating life. For example, in general machinery design with a group of normally stressed bearings running under identical conditions,

rating life = 10,000 operating hours
average life = 50,000 operating hours
last brg. to fail = 150,000 to 200,000 operating hours

Figure 1 is essentially a probability curve since all life curves obtained from empirical figures do not exactly coincide, but do generally conform to



2. Theoretical component load reactions in a radial ball bearing under applied radial load Pr.

this shape. Positive verification whether this general curve applies to all types of bearings has not yet been ascertained.

To test representative sample groups of bearings under many different load conditions is a highly expensive and time-consuming proposition, particularly for the larger bearing sizes which may attain life spans of many years under normal operating conditions. The life tests conducted with bearings are therefore normally performed under accelerated conditions with heavy externally applied loads in order to reduce the life values of the bearings under test to more practicable limits of time. Unfortunately the life values obtained with these tests provide rather scattered points for plotting the life curve. Recent life tests performed in Europe with rolling elements passing through cyclic loaded zones, as occurs in actual bearing operation, have provided less scattered results and have considerably shortened the duration of the test periods.

Life – load – capacity relationship

The internationally accepted relationship for life versus load and capacity is given by

$$L_u = \left(\frac{C}{P}\right)^{\epsilon}$$

where L_u = rating life of the bearing inner ring with a constant direction of loading (10^6 revs)

C = basic load rating or the load permitted for a rating life L_u of (1×10^6 revs)

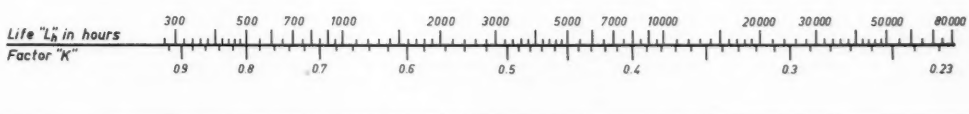
P = equivalent radial load of a radial bearing or equivalent thrust load of a thrust bearing.

ϵ = exponent, which is 3 for ball bearings and 4 for roller bearings.*

The relationship $L = \left(\frac{C}{P}\right)^{\epsilon}$ applies to bearings with an amount of loading which is relatively normal for the bearing size and type. Considerable dispute has existed as to the authenticity of the formula for very lightly loaded bearings or for very heavily loaded bearings where the influence of plastic deformation between the raceways and rolling elements exists. In general, the formula is accepted for the range of $0.1 < \frac{P}{C} < 0.5$.

An examination of the formula $L = \left(\frac{C}{P}\right)^{\epsilon}$ provides an interesting glimpse, on the basis of mathematical relationships, into the influence played by

** The life exponent value of 4 for roller bearings has been recently determined by empirical tests in Europe. On the American continent the value $\epsilon = \frac{10}{3}$ is commonly used.*



3. Nomogram for determining the life factor K for various rated life readings in hours.

DUTY	ASSUMED LIFE IN HOURS	REMARKS
Small precision instruments	1,000	
Domestic electrical appliances	1,000- 2,000	
Small electric motors up to 4 Kw	8,000-10,000	
Medium electric motors	10,000-15,000	
Large stationary electric motors	20,000-30,000	These values are valid for normal vehicles. Where maximum torque is exerted, the life values will be lower.
Light cars, heavy motorcycles	1,000- 2,000	
Heavy cars, light trucks	1,500- 2,500	
Heavy trucks, buses	2,000- 5,000	
Axle bearings for street cars	20,000-25,000	
Axle bearings for passenger trains	25,000	
Axle bearings for freight trains	35,000	
Axle bearings for locomotives	20,000-40,000	These bearings are oversized because the shaft diameter is fixed.
Ships thrust blocks	15,000-25,000	
Ships propellor shafts	80,000	
Agricultural machines	3,000- 6,000	
Universal gears	8,000-15,000	
Machine tool gears	20,000	
Small cold rolling mills	5,000- 6,000	
Large multiple rolling mills	8,000-10,0000	Limited radial space.
Mining machinery at the face	4,000-10,000	Mining safety regulations demand minimum height and weight
Fans for mines	40,000-50,000	
Rope pulleys for conveyors	40,000-60,000	
Paper-making machines (dry action)	50,000-80,000 and more	
Beater Mills	20,000-30,000	Demand high factor of safety

4. Approximate life of precision roller bearings based on application.

continued ▶

the load on the bearing life. Figure 2 represents the equilibrium load reactions to an externally applied radial load P_r, where

γ = pitch angle of the balls
P_0 = peak load reaction on the apex ball
P_1, P_2 = load reactions on lesser loaded balls.

The maximum pressure between the raceways and the apex ball we shall call po. Now we have noted that $L = \left(\frac{C}{P}\right)^3$ for radial ball bearings. In this example we may therefore state $L = \left(\frac{C}{P_r}\right)^3$. The life of a radial ball bearing is therefore inversely proportional to the cube power of the equivalent radial load. Similarily we may state $L \propto \frac{1}{P_0{}^3}$.

It is also known that the relationship between the maximum contact pressure p_0 and the apex load P_0 may be expressed by the relationship $P_0 \propto p_0{}^3$. Thus, substituting for P_0 in the relationship $L \propto \frac{1}{P_0{}^3}$ we obtain, $L \propto \frac{1}{p_0{}^9}$.

The life of a radial ball bearing is therefore inversely proportional to the maximum stress between the raceway and the apex ball to the ninth power. Since the fatigue of a bearing's raceway is largely determined by the stress cycles imposed by the rolling elements running over it under load, we may assume that any additional load increment applied to a ball or roller bearing results in a proportionally larger decrement in its operational life.

Dynamic load carrying capacity— if a group of apparently identical bearings are tested such that their outer rings are fixed and the inner ring rotates with the shaft, the basic load rating is the constant stationary radial load which the bearings can endure for a rating life of one million revolutions of the inner ring. If the dynamic carrying capacity is to be considered at a specific operating speed, the load rating is based upon a fixed reference life value.

Static load carrying capacity— the load which a bearing can sustain while at rest or when undergoing a slight oscillatory movement, providing that the permanent deformation between any rolling element and raceway does not exceed 0.01% of the rolling element diameter.

Basic load rating

Figure 6 indicates the formulae employed for calculating the basic load rating C for radial type

Type	1	2	3	4	5	6	7	8	9	10	Type	1	2	3	4	5	6	7	8	9	10
Deep Groove Ball Bearing	●	●	○	●	○	◐	●	●	●	◐	Cylindrical Roller Bearing	●	◐	○	–	●	◐	●	–	–	○
Magneto Bearing	●	●	◐	◐	●	◐	●	●	●	○	Needle Roller Bearing	●	○	●	–	●	○	○	○	○	○
Single Row Angular Contact Ball Bearing	●	●	○	◐	◐	○	●	●	●	○	Taper Roller Bearing	●	●	○	◐	●	◐	●	◐	○	○
Double Row Angular Contact Ball Bearing	●	●	○	●	○	○	○	◐	○	○	Single Row Self-Aligning Roller Bearing	●	◐	○	●	○	●	○	○	○	●
Double Row Self-Aligning Ball Bearing	●	◐	○	●	○	●	○	○	○	●	Double Row Self-Aligning Roller Bearing	●	●	○	●	○	●	○	○	○	●
Cylindrical Roller Bearing	●	○	●	–	●	◐	●	●	●	◐	Single Thrust Ball Bearing	–	●	–	–	●	○	●	○	○	–
Cylindrical Roller Bearing	●	◐	◐	–	●	◐	●	–	–	○	Double Thrust Ball Bearing	–	●	–	–	●	○	○	○	○	–

● Applicable without restriction ◐ Applicable with restriction ○ Not applicable – Does not come into consideration

The duties detailed in the above chart are defined as:

1. Radial load.
2. Thrust load.
3. Axial freedom provided within the bearing although both races fit tightly on their seatings.
4. Axial freedom provided by either the inner or outer race being a push fit on its seating.
5. Assemblies which require detachable bearings.
6. Compensation for misalignment.
7. Available with increased accuracy.
8. Suitable for speeds above normal.
9. Particularly noiseless in running.
10. Can be used with taper adapter sleeves for securing the inner race to the shaft.

5. Characteristics of the various forms of bearing construction.

bearings and *Ca* for thrust type bearings. From these formulae it may be discerned that the basic load rating is a determined factor for any particular manufactured bearing size and type according to the internal design evolved by the manufacture. Lists or tables of the basic load ratings for standard bearings are normally provided in the bearing manufacturers' catalogs.

It should be emphasized that the formulae in Figure 6 are provided only to aid the reader in comprehending the means by which the bearing life is calculated. In practice, many additional factors such as static carrying capacity, raceway curvatures, pitch diameter of the rolling complement and so on would be further analyzed.

A common misconception is that the greater the number of rolling elements, the greater is the carrying capacity of the bearing, with little regard for the size of the rolling elements. An examination of the basic load rating formulae shows that C varies according to the number of rolling elements (balls or rollers) to a power less than unity but to a power exceeding unity for the rolling element diameter. As far as bearing capacity is concerned, therefore, the size of the rolling elements plays a more significant role than their number.

Simpler derivations of the formula $L = \left(\frac{C}{P}\right)^{\epsilon}$ are commonly employed by bearing manufacturers to facilitate the calculating procedure. Such a derivation for radial bearings is expressed by the relationship

$$K = \frac{P}{Cn}$$

where P = dynamic equivalent radial load at a speed (n)

Cn = relative carrying capacity at a speed (n) (Basic load rating of the bearing C multiplied by an empirical speed factor such that the carrying capacity varies inversely as the operating speed).

K = a life factor.

The relative carrying capacity Cn is generally provided in the bearing manufacturers' catalogs for any given bearing at a fixed operating speed (n). The dynamic equivalent radial load is calculated according to the formula given in Figure 6 depending on the type of bearing and the magnitude of the axial and radial loads.

Once the factor K has been determined a simple comparison with the nomogram shown in Figure 3 provides the corresponding rating life of the bearing in hours. The formula $K = \frac{P}{Cn}$ may of course be converted to $Cn = \frac{P}{K}$, for the calculation of the required minimum carrying capacity or,

BASIC LOAD RATINGS	**EQUIVALENT RADIAL THRUST LOADS**
Ball Bearings	
Radial, angular contact except filling slot	
$C = f_c \,.\, (i \,.\, \cos\alpha)^{0.7} \,.\, Z^{2/3} \,.\, D^{1.8}$ balls $\geqslant 1$ inch $C = f_c \,.\, (i \,.\, \cos\alpha)^{0.7} \,.\, Z^{2/3} \,.\, D^{1.4}$ balls > 1 inch	$P = XVF_r + YF_a$
Thrust, single row, single and double direction thrust	
BALLS $\geqslant 1$ inch dia. $C_a = fc \,.\, Z^{2/3} \,.\, D^{1.8}$ $(\alpha = 90°)$ $C_a = fc \,.\, (\cos\alpha)^{0.7} \,.\, \tan\alpha \,.\, Z^{2/3} \,.\, D^{1.8}$ $(\alpha \neq 90°)$ balls > 1 inch dia. $C_a = f_c \,.\, Z^{2/3} \,.\, D^{1.4}$ $(\alpha = 90°)$ $C_a = f_c \,.\, (\cos\alpha)^{0.7} \,.\, \tan\alpha \,.\, Z^{2/3} \,.\, D^{1.4}$ $(\alpha \neq 90°)$	$P_a = XF_r + YF_a$
Roller Bearings	**(tapered and self-aligning types)**
Radial Type	
$C = f_c \,.\, (i \,.\, l_{eff} \,.\, \cos\alpha)^{7/9} \,.\, Z^{3/4} \,.\, D^{29/27}$	$P = XVF_r + YF_a$
Thrust single row, single and double direction	
$C_a = f_c \,.\, l_{eff}{}^{7/9} \,.\, Z^{3/4} \,.\, D^{29/27}$ $(\alpha = 90°)$ $C_a = f_c \,.\, (l_{eff} \,.\, \cos\alpha)^{7/9} \,.\, \tan\alpha \,.\, Z^{3/4} \,.\, D^{29/27}$ $(\alpha \neq 90°)$	$P = XF_r + YF_a$

Explanation of symbols

i = number of rows of ball or rollers in any one bearing
$_a$ = nominal contact angle (ie) the nominal angle between the line of action of the ball or roller load and a plane perpendicular to the bearing axis
Z = number of balls or rollers per row
D = ball or roller diameter (mean diameter for tapered rollers)
f_c = a factor which depends on the units used, the geometry of the bearing components, the accuracy to which the various bearing parts are made and the material
l_{eff} = effective length of contact between one roller and that ring where the contact is the shortest (over-all roller length minus roller champers or minus grinding undercuts).
P = equivalent radial load
Pa = equivalent thrust load
X = a radial factor
Y = a thrust factor
Fr = the radial load
Fa = the thrust load
V = a rotation factor which is used as a matter of precaution due to a lack of sufficient experimental evidence.

6. Basic formula for calculating basic load ratings.

continued ▶

$p = KCn$, to determine the maximum equivalent radial load which a bearing may absorb.

Equivalent load

If a bearing is subjected to an obliquely applied external load the equivalent load must first be determined. The equivalent radial load (P) is that pure radial load which would cause the same amount of fatigue on a radial type bearing as the obliquely applied external load. Likewise, the equivalent axial load (Pa) is that pure axial load which would cause the same amount of fatigue on a thrust bearing as the obliquely applied external load.

Typical formulae for calculating the equivalent loads for various types of bearings are provided in Figure 6. The factors X, Y, and V are normally provided in the bearing manufacturers' catalogues.

Similar formulae are employed for calculating the equivalent static loads of bearings; however, a comprehensive explanation of static capacity necessitates a discussion of such things as circumferential loading, point and line contact which is not possible in this article.

An interesting and exceptional case is the consideration of the equivalent load characteristics of a cylindrical roller bearing. In this type of bearing the radial load component is absorbed through the inner and outer rings via the cyclindrical rollers. The axial load component, however, is transferred from the inner side of one inner ring rib (or shoulder) through the face sides of the roller and into the inner side of the outer ring rib.

The fatigue of the bearing raceway is therefore not influenced by the axial load component. This makes the cylindrical roller bearing more suitable for some applications than other types of roller bearings, such as taper or self-aligning roller bearings (e.g. railway axle box applications). The axial load carrying capacity of cylindrical roller bearings is dependent upon: the area, degree of parallelism and quality of surface finish of the inner faces of the ribs; effectiveness of heat dissipation of surfaces sliding on each other; type and quality of lubricant used; contact pressure between ribs and rollers.

Effect of operating speed on life

The life of a bearing varies inversely as the rotational speed. Examples of the approximate rotational speed limits for various types of precision bearings are provided in Figure 7.

These values correspond to a rating life of approximately 5,000 hours with normal loading and lubrication. The rotational speed limit is largely determined by the internal design of the bearing type, of which the following factors are of prime importance.

a) ability of outer ring to absorb the centrifugal load of the rolling elements
b) magnitude of centrifugal forces due to mass of rotating elements
c) coefficient of friction for rolling elements and raceway
d) mass of cage or retainer
e) means of guidance of cage or retainer
f) run-out of rotating ring
g) type, amount and quality of lubrication.

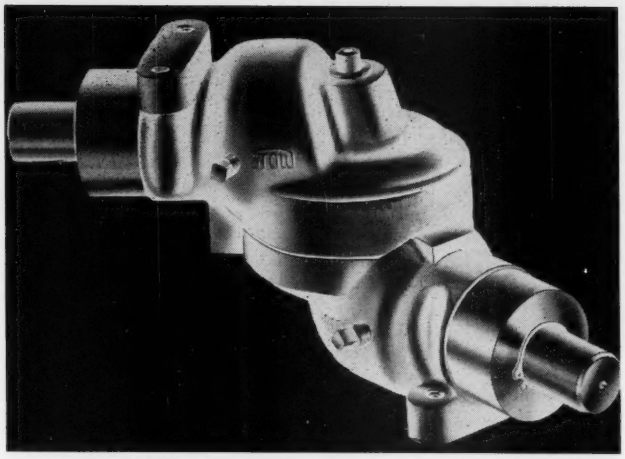
The maximum permissible operating speed for many bearing types may be increased by:

a) increasing the running accuracy (reducing run-out of rotating ring)
b) reducing the mass of the cage or retainer by employing light alloy metals or plastic materials instead of the commonly employed steel or bronze materials
c) providing an improved form of cage guidance or improved means of lubrication between cage and guiding surface. ★

BEARING TYPE		ROTATIONAL SPEED LIMIT n (r.p.m.)
Small deep-groove ball bearings Small self-aligning ball bearings Small magneto ball bearings	up to 30 mm O.D.	$\frac{900{,}000}{D+10}$
Deep-groove ball bearings Self-aligning ball bearings Magneto ball bearings	over 30 mm O.D.	$\frac{450{,}000}{D-10}$
Angular contact ball bearings, single row Cylindrical roller bearings		$\frac{450{,}000}{D-10}$
Angular contact ball bearings, double row Taper roller bearings Double row self-aligning roller bearings, series 222 & 223		$\frac{320{,}000}{D-10}$
Double row self-aligning roller bearings, series 230 & 231 Single row self-aligning roller bearings, series 202, 203 & 204		$\frac{230{,}000}{D-10}$
Needle bearings, full complement		$\frac{120{,}000}{D-10}$
Thrust ball bearings with grooved raceways		$\frac{140{,}000}{Dg-10}$

D=outer ring O.D. (mm), Dg=housing washer O.D. (mm).

7. Approximate speed limits for various types and sizes of precision bearings.



Transmit rotary motion through angles to 360° with this

Revolutionary geared joint

1. This geared joint simplifies torque transmission around obstacles.

In building ships, as in many other apparatus, design for the shell or hull and propulsion equipment comes first. All other equipment used on board must then be fitted into this basic structure — frequently around obstacles created by the fixed hull design.

Shipboard installation of remote control linkages for valves, for instance, which often involves leading these controls around several obstacles, has been greatly simplified by a new geared joint developed by the Stow Manufacturing Company of Birmingham, N.Y. The units consist of a double bevel gear in combination with two bevel pinions mounted in a housing that swivels through 300 deg., allowing the transmission of rotary motion around sharp corners, where necessary. The geared joint, although developed primarily for this shipboard application, is adaptable for other jobs.

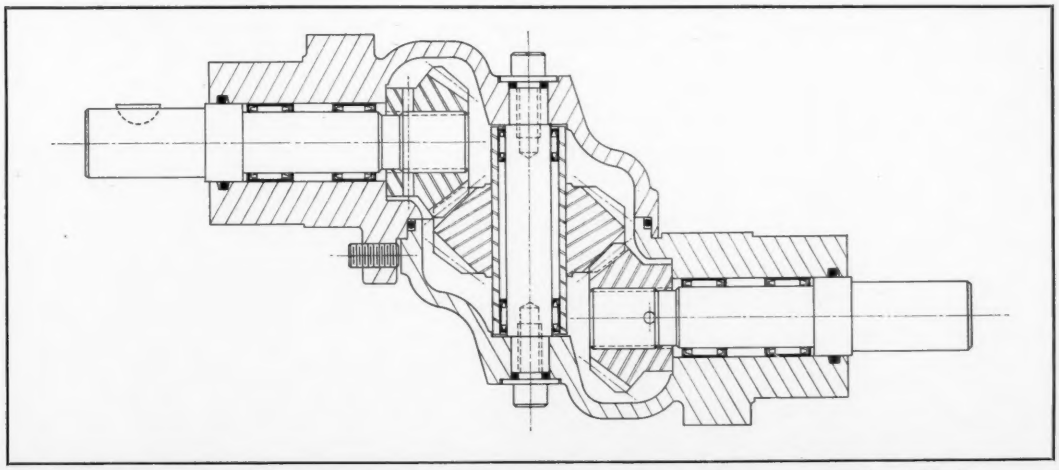
Six Torrington DC type needle bearings are used in each joint. Two bearings support each of the pinion shafts. The centre bevel gear assembly carries a pair of needle bearings that run directly on the hardened locking bolt. The bolt, in addition to carrying the bevel gear assembly, also locks the two halves of the geared joint together, and serves as the pivot for the angular adjustment of the joint. The use of the needle bearings gave increased power transmission efficiency to the joints, and permitted speeds up to 500 rpm. O-ring seals prevent contamination of the gears and bearings and keep the lubricant within the unit.

Smaller, lighter — same torque

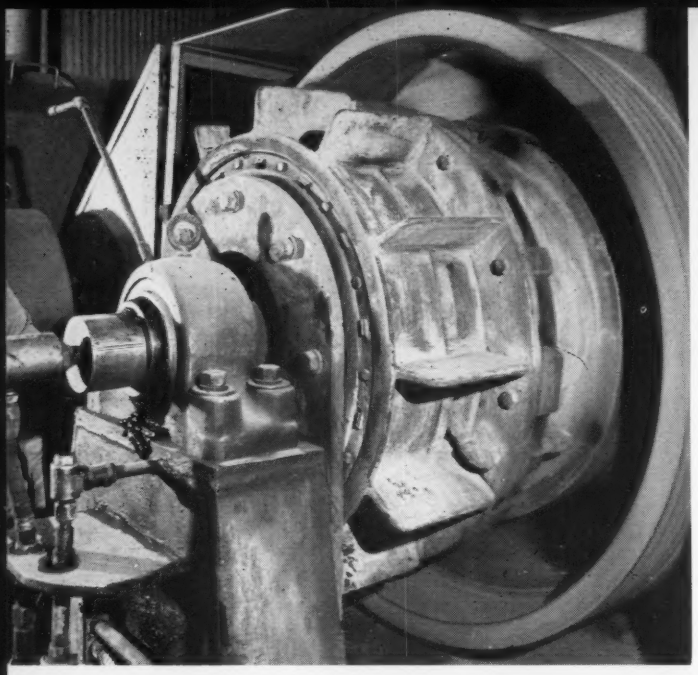
The new geared joints are smaller and lighter than any previous designs having the same torque capacities. Installation problems are simplified. For instance, flexible shafts or rigid reach-rods with universal joints at each end may be used with the geared joint.

Installation involves attaching the control shafts by means of pins or keyways to the ends of the geared joint. The correct angle for the assembly is then set by rotating the arms. The angle is locked with a setscrew, and the joint is bolted in place. Several geared joints may be used in a single control linkage where numerous obstacles exist.

In addition to application on board ships, the geared joints also find use in power plants, chemical plants, nuclear reactors or other installations requiring the transmission of mechanical power through almost any angle. ★



2. Diagram of the geared joint. Note that two needle type bearings are used to support each of the three gears.



Air clutches combine with remote control

Combination solves difficult power transmission problems

1. Air clutch assembly in brick manufacturing plant.

The use of mechanical clutches in power transmission equipment is generally familiar to most engineers. The application of air clutches, combined with remote control, is not quite so common. Here however, are the stories of how three installations saved thousands of dollars, increased production, and solved difficult power transmission problems.

In Port Colborne, Ontario, Maple Leaf Milling Company, Ltd., uses air clutches to obtain high-efficiency power transmission by remote control and cut annual ship unloading costs by $24,000.

The unloading system removes grain from ship holds at a rate of 35,000 bushels per hour. Material is fed to a vertical elevator by four dragline scoops in the hold. The forward and reverse action of each scoop is controlled by an operator carrying a small portable remote control panel in his hands. The operator can be either in the hold or on the ship's deck while supervising this operation.

The scoop operating mechanism is set up in two banks, mounted at the dockside end of the elevator. Each bank is equipped with two "lead-line" and two "pull-back" drums, driven through Fawick Type E Air-Ring Clutches from a 40 hp electric motor. Each drum is equipped with an actuating clutch mounted on the chain driven drum shaft and a spring-and-air actuated brake at the other end of the drum. The lead-line drum operates a ½" cable and the pull-back drum utilizes a 1¼" rope.

Many operating advantages

This unusual remote control technique and its efficiencies have produced the following operating advantages:

1) cut manpower requirements 30%
2) reduced loading time 20%
3) reduced operating power requirements 60%
4) eliminated clutch maintenance for three years.

The entire cost of the new ship unloading system was approximately $24,000. Recently, *yearly* savings due mainly to the clutches were estimated at $24,000.

Air clutch operation

The Fawick Airflex Clutches used at Maple Leaf feature an expanding element assembly designed for heavy duty, medium speed cyclic operations and high acceleration loads. The element assembly is mounted on the drive shaft. When actuated by the control panel operator, air expands the rubber actuating tube and the friction shoes engage the clutch drum which is independently mounted on the driven shaft. When air pressure is released, disengagement is ensured by the action of release springs which counteract centrifugal force at operating speed.

Engagement and disengagement are shock-free and instantaneous, allowing the operators to direct the movements of the dragline scoops with great accuracy.

The hand-held controls can be moved to the most advantageous point during unloading and needn't be down in the hold with the cargo. In the case of Maple Leaf Milling Company, four scoops effectively empty their cargoes of wheat and grain. Different unloading arrangements can be used for other types of cargo.

Increase production of brick presses

Another manufacturer who uses power transmission by remote control is Kaiser Refractories and Chemical Division, Moss Landing, California. At Kaiser, 1,000-ton brick presses produce special-sized brick in a single-cycle operation whose productivity has increased 25 per cent since modernization with air clutch units.

The presses, each powered by a 54-horsepower, alternating current-adjustable, variable speed electric motor, turn out rectangular bricks in a continuous automatic operation, as well as making odd-shaped bricks.

Braking system safety feature

The braking system is an important safety feature in pressing odd-shaped bricks because individual control

and handling are required. The operator must "dig the brick," or, direct the flow of the bricks' raw materials — chrome and periclase — into the general shape of the brick. The press ram then completes the 8-second cycle by compressing the brick into its finished shape.

The 1,000-ton press will not recycle until the operator pushes a remote control button.

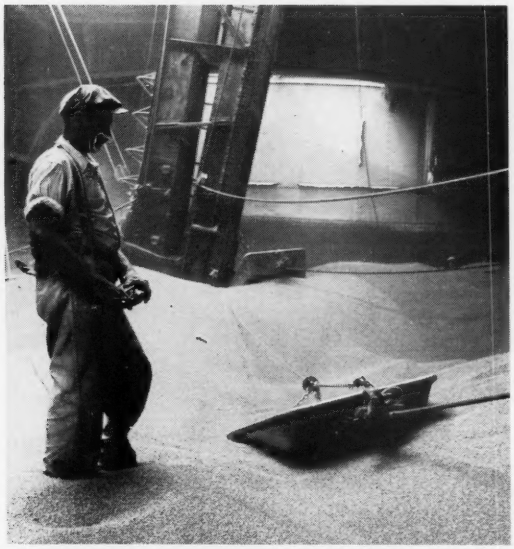
Drum-type air operation and a 360° friction surface assure instant response to control and maximum operating torque. The rubber actuating tube automatically compensates for friction shoe wear, eliminating need for adjustment.

Production has increased 25% with the new remote controlled units and maintenance problems have been virtually eliminated.

Clutches compensate for shaft elongation

Plant designers at Tidewater Oil Company, Avon, California, chose air-actuated clutches with remote controls for power transmission as the answer to their unusual thermal expansion problem in the boiler house.

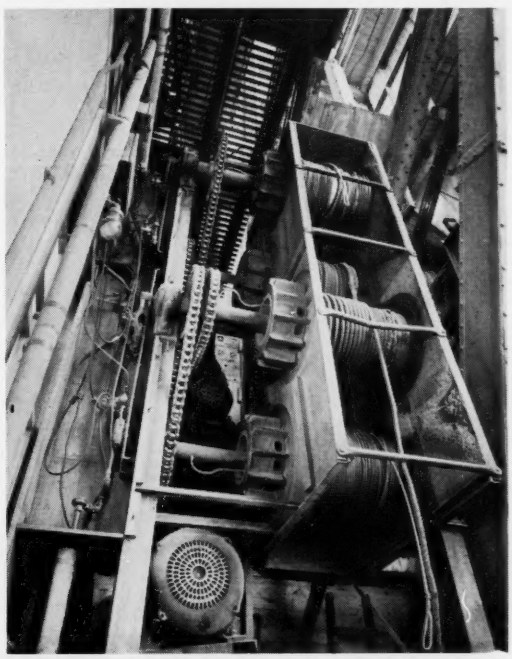
As shafts of two 70-inch steam plant draft fans come to operating temperature (750 F) there is an axial



2. Operator deep in hold of ship controls unloading.

3. Deck operator keeps hand on remote control box.

4. General view of clutch controlled ship unloading elevator.



5. Closeup of the clutch and line arrangement at Maple Leaf Milling.

continued ▶

elongation of ⅜ to ½ inch, creating a hazard to bearings and gears in the power train.

Four clutches, specifically designed for heavy-duty operation, are used to couple main and auxiliary power sources to each of the two dual-driven fans. One fan, a forced draft fan, aids boiler combustion, while the other, an induced draft fan, removes flue gases. Auxiliary and main power sources are located at opposite ends of the shafts. The prime movers for both fans are steam turbines driving through reduction gears. Auxiliary power on the forced draft fan comes from an electric motor, while another steam turbine provides similar drive for the induced draft fan.

The main and auxiliary prime movers for the induced draft fan are steam turbines rated 1,250 hp, 3,470/690 rpm. The main prime mover for the forced draft fan is a steam turbine rated 450 hp, 3,540/880 rpm; the auxiliary prime mover is a 450 hp electric motor.

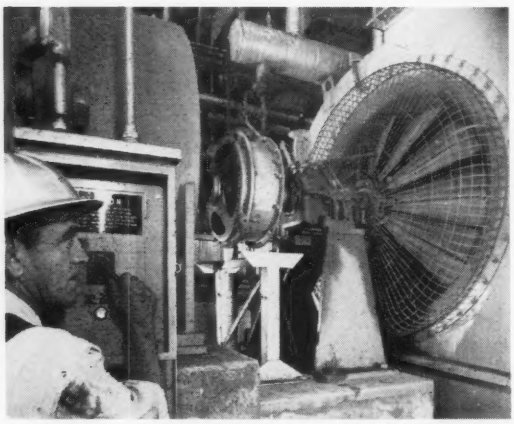
All turbines take steam at 600 psig, 750 F, and exhaust at 40 psig. Capacity is 500,000 lb/hr of steam at 600 psi, 750 F.

Independent mounting absorbs motion

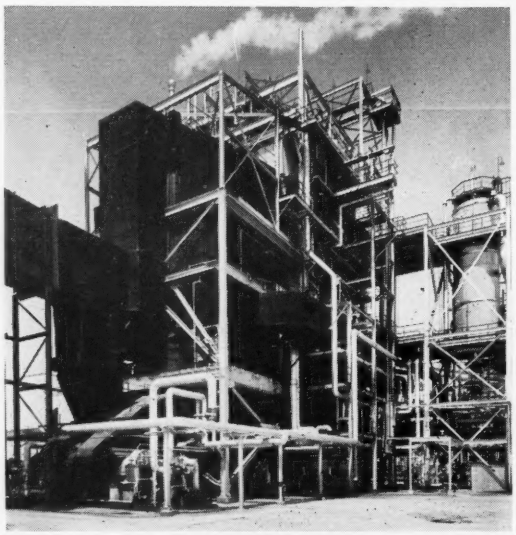
Independent mounting is an inherent advantage of these clutches which made them practical for the Tidewater application. Each clutch drum is mounted on the fan, or driven, shaft. The clutch element assembly is mounted on the driving shaft. As the shaft heats up, an automatic timing control disengages the clutch at regular intervals allowing the drum to move further into the clutch element assembly. Friction shoes then regrip the drum in a new position, without interrupting speed and efficiency.

Open construction of the friction shoes permits passage of cooling air and rapid heat dissipation from the friction surface. At Tidewater, this feature allows gradual fan start-up through slip-clutch action. This advantage is also put to use when switching from the main prime movers to auxiliary power sources. Since the shaft is rotating at the speed provided by the main power source, the clutch that is coupled with the auxiliary is allowed to slip until the auxiliary power source assumes full power, resulting in a smooth switch without shutdown or time loss.

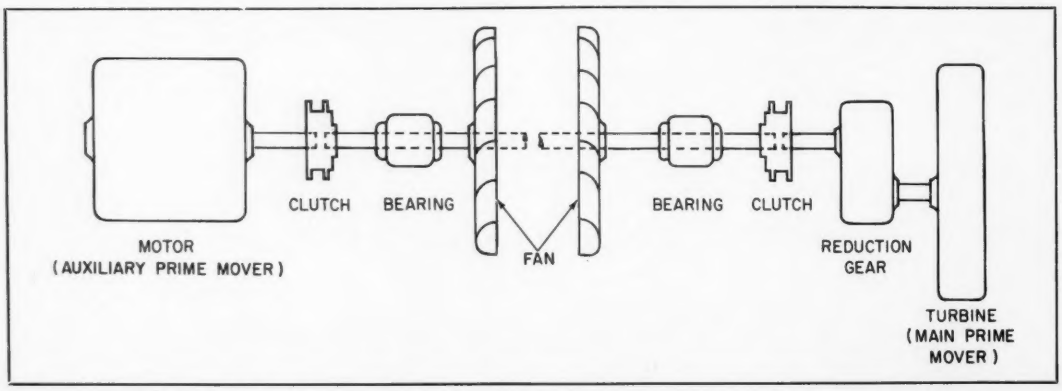
Remote controls on these draft fan shafts solve a unique design problem. Disengagement of one power source and simultaneous engagement of the other is smooth, automatic and faultless. There is no lurch, grind, or jerk to damage power train components. The thermal expansion warm-up problem is solved by the automatic release and regrip feature. ★



6. Tidewater fan control arrangement with air clutch.



7. Size of draft fan installation is easily discerned.



8. Arrangement of forced draft fan system showing the two air clutches on either side of the heavy duty fan.

What you should know about miniature bearings

Principal characteristics of the five main types

Colby G. Beecher
Application Engineer
Miniature Precision Bearings Inc.

Although designers and manufacturers have been using precision ball bearings in one form or another for nearly a century (the first true precision bearings were made for bicycles), the past decade has seen the use of high-precision miniature bearings, that is, bearings whose outer diameter is less than ⅜ in. Brought about by the tremendous increase in miniaturized products, miniature ball, pivot and thrust bearings are now used in over 2,500 different applications ranging from super-sensitive gyroscope components to high speed dental hand-pieces. Wherever there's a need to reduce friction, size and weight, there's probably an application for a miniature bearing of some type.

Today there are over 550 types and sizes of miniature bearings listed in manufacturers' catalogues. Because of this wide range of types, it is important that designers become familiar with the basic operating characteristics and advantages of the various types and sizes. This familiarization is considerably simplified if the several bearing types of constructions are grouped into five categories:

1. Radial retainer bearings
2. Full race radial bearings
3. High speed bearings
4. Pivot bearings
5. Thrust bearings

Within each major type there may be design variations such as flanges, shields, and ring widths. These are discussed in the descriptions of each basic type that follow.

Radial retainer bearings

The radial retainer ball bearing (often called the Conrad type) is the most versatile of all ball bearing types. It can support radial loads, thrust loads from either direction, or combined radial and thrust loads.

Most radial retainer bearings utilize a precision-formed stainless steel retainer to separate and space the balls. This retainer may be of the standard one-piece construction or the two-piece ribbon type separator. Ribbon type retainers are available, as a rule, only in the larger sizes. Radial retainer bearings have the lowest starting torque values of radial bearing types, and may be operated continuously at speeds in excess of 35,000 rpm.

The standard material for radial retainer bearings is AISI 44OC stainless steel. Most sizes are also made in SAE 52100 steel and many sizes in non-magnetic beryllium copper.

Radial retainer bearings with construction variations such as flanges, single or double shields, and extended inner rings are also available to accommodate a wide variety of service conditions and housing designs.

A flanged outer ring, with the flange face square to the outside diameter permits accurate bearing mounting in a through-bore housing without a shoulder or retainer ring.

External shields of the labyrinth type are held to the outer ring by snap wires and maintain close clearances to the sides and bottoms of grooves in the inner ring OD. Oil films tend to complete the sealing action of this type seal while having no effect on bearing torque.

The extended inner ring bearing has its inner ring extended .015 in. beyond the outer ring on each side. It is extremely useful in applications where shaft components, such as gears, must be accurately located with respect to the housing and the use of separate shaft spacers or bosses would introduce location error and complicate assembly techniques.

The ability of radial retainer bearings to carry thrust in either direction is an important and useful characteristic. It permits their use in "fixed and floating" mountings in which one bearing locates the axial position of the shaft assembly and the other bearing floats axially to compensate for unequal linear thermal expansion of the shaft and the housing.

Typical applications for radial retainer bearings are gyro gimbals, synchros, servos, small miniature motors,

continued ▶

high speed gear trains, potentiometers, and miniature clutches.

Radial retainer ball bearings can be purchased in many ranges of internal radial clearance to meet the specific conditions of an application. The selection of the proper range of radial play is often of prime importance in the success of a bearing application. In sensitive applications where the amount of radial clearance is an important factor, it is recommended that the manufacturer's engineering staff be consulted for their advice. It has been found that, in many cases, excessively "tight" radial play requirements do not improve and may even prevent successful bearing operation.

Radial full race bearings

A radial full race ball bearing has no retainer, and the annular space between inner and outer races is filled with balls. To assemble a bearing of this type, filling notches are ground in the inner and outer ring lands. Once assembled, these bearings are virtually non-separable.

Radial full race bearings have the highest radial load capacity of all radial types, but due to interruption of the race shoulders by the filling notch, they have relatively low thrust capacity. A typical application of radial full race bearings is on the final pass or output shaft of low speed, high torque, gear trains.

Because of the contact between adjacent balls, radial full race bearings have relatively high torque levels. However, at very high speeds they have the unique characteristic of maintaining equal ball spacing and have been and are successfully operating in applications such as dental handpieces and other intermittent service applications at speeds in excess of 350,000 rpm.

Radial full race bearings are made with or without flanges, and are also available with extended inner rings.

High speed bearings

High speed miniature bearings are usually constructed to have phenolic retainers. This material can be vacuum impregnated with oil to provide an active lubricant reservoir within the bearing. The phenolic material combines the advantages of light weight, low friction, and high lubricant retention — all desirable features for high speed bearing operation. High speed bearings are recommended for continuous operation at speeds in excess of 25,000 rpm.

Due to their different retainer construction, high speed bearings have slightly greater starting torque than comparable size radial retainer bearings, but at high operating speeds they have very low running torque.

Normally assembled to an initial contact angle of approximately 20 deg., these bearings are sometimes called angular contact bearings. Manufacturers can meet other contact angle specifications to accommodate specific application requirements. The angular contact construction not only increases the thrust capacity and the axial rigidity of the bearing, but allows each bearing to take thrust loads in only one direction. Consequently, angular contact bearings are normally mounted at opposite shaft ends with their contact angles opposed, or on one end of the shaft as an opposed pair.

Conrad-type bearings are also made with high-speed phenolic retainers. These bearings can support thrust loads from both directions because of deep race on both the inner and outer rings. In high speed Conrad-type bearings, this deep groove construction also offers some gain in lubricant retention.

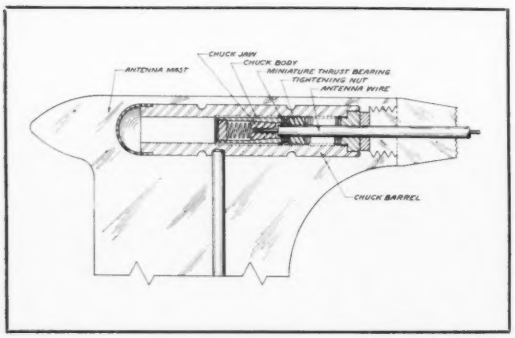
All high speed bearing types can usually be furnished with flanges and some can be supplied with shields. All types can also be supplied in matched duplexed pairs where greater load capacity and rigidity are required.

Typical applications for high speed bearings are gyro spin bearings, recorder tape guides, precision high speed turbines, and miniature memory drums.

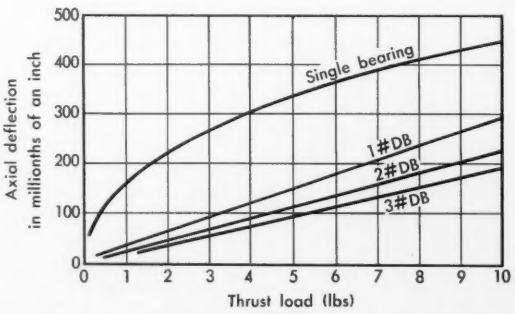
Duplexed bearings are a pair of closly dimensionally-matched bearings to which a predetermined preload is built in. The preload value is usually determined by the degree of axial deflection allowable in the application. Radial retainer type bearings as well as high speed type bearings may be duplexed where it is necessary to position a shaft or housing and control their locations with respect to each other to specified limits when subjected to a known externally-applied force. Duplexed pairs also are used to minimize the mass-shift effect in gyroscope rotors and provide a known stiffness that is equal in either axial direction or in radial direction.

Pivot bearings

Pivot bearings are the "midgets" of the miniature bearing industry. One size, containing four balls and



2. A miniature thrust bearing is used in this chuck assembly of an aircraft antenna mast.



3. Graph of axial deflection versus thrust load for miniature precision bearing.

a cap, is only .0590-in. in diameter, .0472-in. thick, and weighs .02 grams.

Pivot bearings combine low friction torque characteristics with an ability to withstand substantial shock loads.

Due to the conical shaft configuration adjustments for minimum radial and end play can be easily made. These characteristics allow a pivot bearing to replace jewel bearings in many applications.

There are three types of pivot bearings available, all designed to operate on shaft cone sections of 60 deg. included angle. These are:

1. Pivot bearings with raceway
2. Pivot bearings with a spherical seat
3. Angular contact pivot bearings.

The closed-end design of the first two types will not allow through-passage of a shaft. The spherical-seat type of pivot bearing has a spherically-formed race that permits as much as 10 deg. total misalignment between shaft and housing.

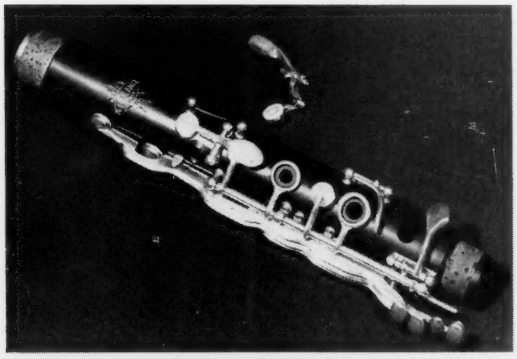
The raceway-type of pivot bearing utilizes a ball groove race, permitting close control of internal clearances and contact angle, resulting in very low torque values. This type of design permits up to 4 deg. total misalignment.

Angular contact pivot bearings are made with an open end design allowing the pivot shaft to pass through the bearing. This type is designed to receive combined loads on conical 60 deg. pivot points, the angle at which best performance is obtained under most common load conditions.

All pivot bearings must operate under a thrust load. They are not recommended for pure radial loading or translational motion. Maximum operating speed depends on lubrication and load, and seldom exceeds 10,000 rpm.

Cones or pivot shafts are usually supplied by the user and must be made to the design limits specified in manufacturers' catalogues. Hardness, surface finish, and trueness of conical section are particularly essential for proper bearing operation. Pivot shafts should be made of tru-hardening high carbon steel, hardened to a minimum of 60 Rockwell C and ground and polished to a 2 micro-inch surface finish. The conical bearing seat should be truly conical within .0002" over its entire length.

Typical applications of pivot bearings are found in flow meters, sub-miniature potentiometers, and low torque, accurate response electric meters. They are often used instead of jewel pivots in instruments that must support shock loads in service.



4. To improve the fingering action on this clarinet tiny pivot bearings have been fitted into the keys.

Thrust bearings

Thrust bearings are used to support pure thrust loads. Thrust bearings are made with stainless steel retainers and are manufactured to precision tolerances.

The deep groove design permits an optimum combination of load carrying ability with speed capacity. Thrust bearings can be operated at speeds in excess of 10,000 rpm; they cannot support radial loads or overturning moment loading.

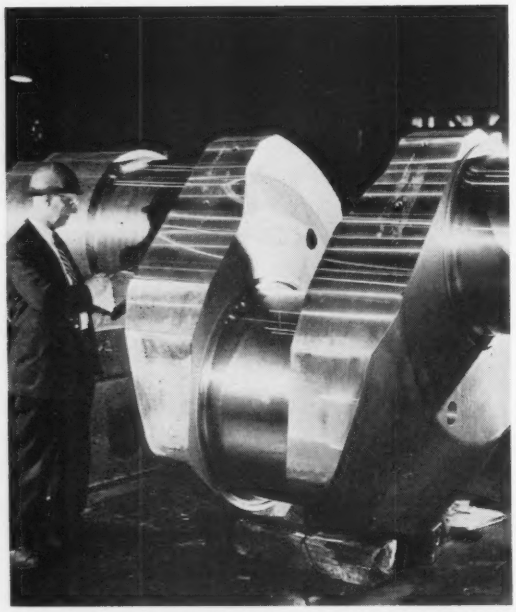
Typical applications for thrust bearing are in high velocity flow meters, tuning devices, and fuel metering equipment for aircraft and rocket engines.

Beyond the range of the basic types and sizes of miniature bearings lie special bearings. These are usually grouped into two categories: (1) modifications of standard "catalog line" bearings and (2) completely special designs.

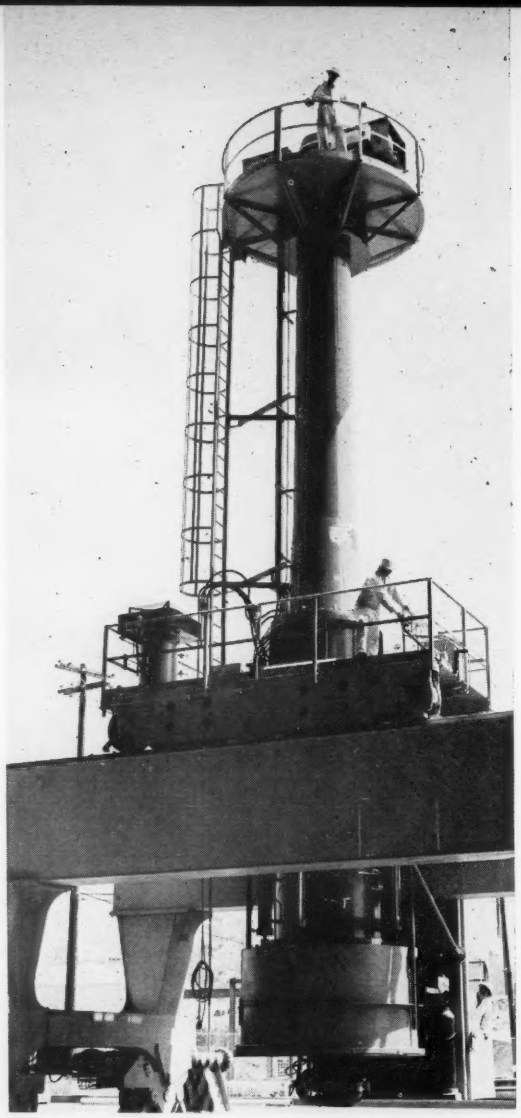
Although it may appear that some problems can be solved only by using a special bearing, a miniature bearing manufacturer's engineering staff can offer to point out design changes that may make it possible to use either a standard bearing or a modified standard type or size. In other words, don't jump at a special without considering first whether your design could be modified to accept a standard bearing or if a modified standard might fill the bill. You'll save on tooling costs as well as speeding up delivery. ★

5. Resting on the head of a common pin, this miniature bearing makes a pretty picture.

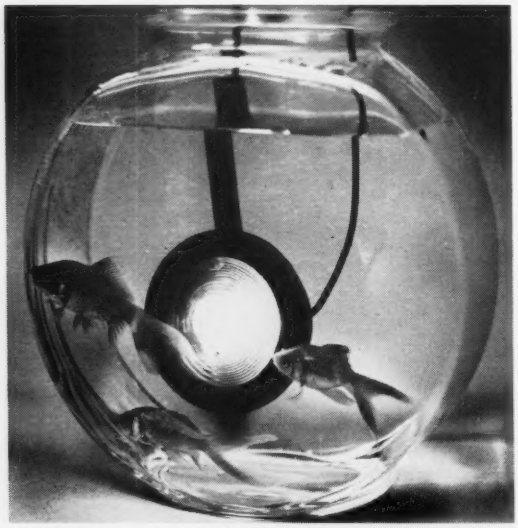
Designews in pictures



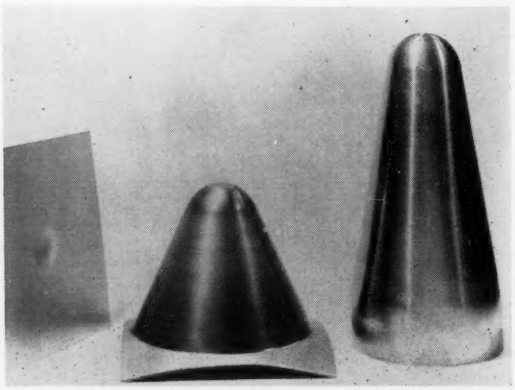
This is the largest single-throw, one-piece crankshaft ever produced. It was forged by U.S. Steel for an extrusion press in Alabama.



Giant fuel handling cask 54 ft. high will handle and load reactor components for Hallam nuclear power plant in Nebraska.



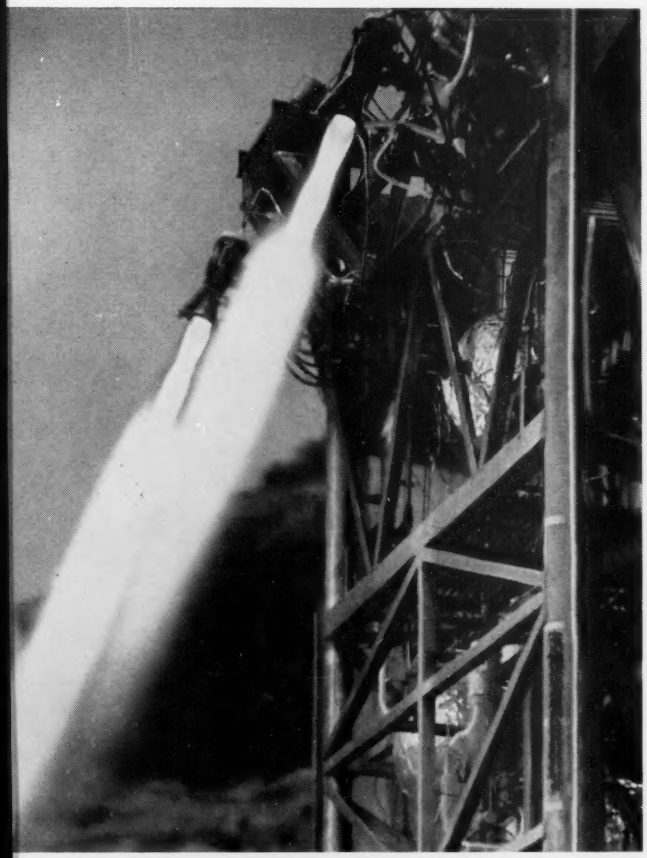
The lamp in this goldfish bowl was submerged for 48 hours to test its water-resistance. Lens, bulb and reflector are one sealed, compact, replaceable unit.



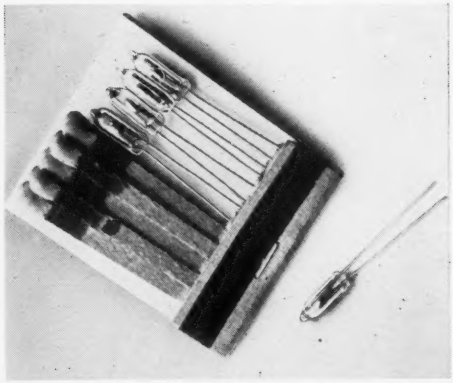
Three steps in metal-forming to transform a stainless steel blank into a satellite nose cone. This cone, weighing only 13 ounces, is now orbiting the earth.

As part of its program to find new ideas for aluminum, Aluminum Co. of America commissioned this garden with abstract aluminum fountain shaped much like a huge flower.

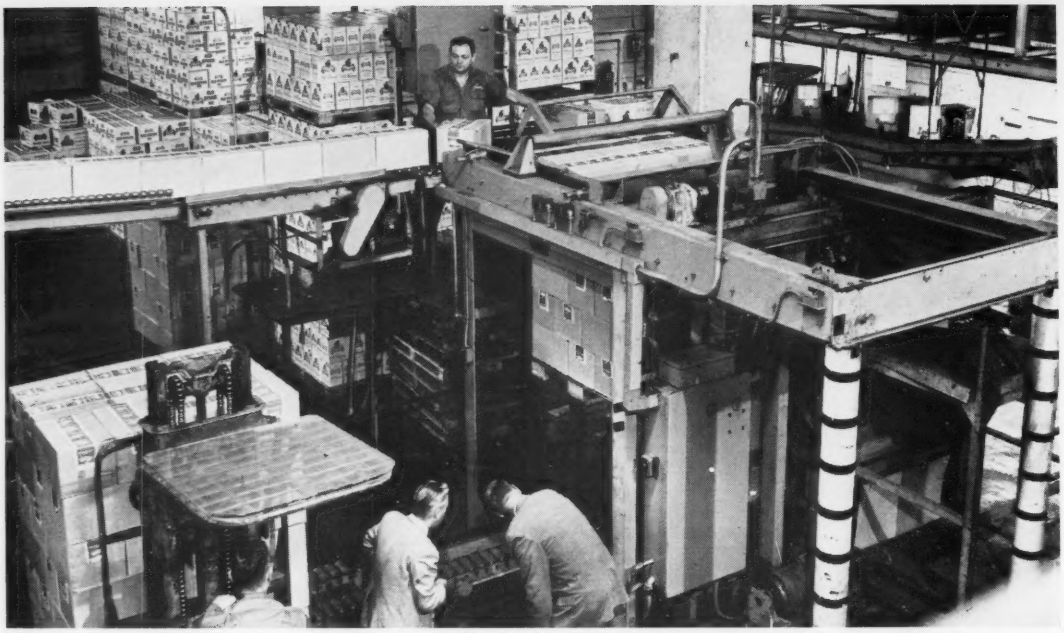
Seamless tantalum tubing in lengths up to 60 feet has been developed by Calumet & Hecla of Canada. Tubing is made by extruding a solid piece of metal through a die.



The vernier engines responsible for the final aim and velocity of the Atlas missile in a recent test, ran for a record of 1,930 seconds, nearly six times longer than normal operation requires.



The world's smallest commercially available mercury switch (½ in. length, .162 in. diameter, 1/10 amp rating) is suited for such applications as hearing-aid switch, small on-off switch and paging devices.



General view of the Mathews semi-automatic pallet loader, showing the operator arranging rows of cartons on the ball transfer table.

Canadian design in materials handling

Incorporates every type of mechanical power transmission equipment

E. T. Burch
Staff writer

To materials handling experts, piling packaged goods on wooden pallets, or skids, for easy handling or warehousing by fork-lift trucks is old hat. So is the other end of the packaging operation—the filling of individual packages, labeling, and inserting them into shipping cartons.

But a serious gap existed between the two operations. A good example of the gap was in the modern high-volume brewing industry. High-speed automatic equipment takes beer or ale from the vats, fills the bottles at the rate of 500 per minute, caps them, inspects them, glues the labels on neatly, puts the bottles in cartons — then glues, closes, and seals the cartons.

Following this highly organized operation, the cartons had to be taken from the carton-filling machines by hand by a crew of muscle-men, and stacked on pallets ready for the fork-lift trucks to trundle them away to storage or shipping. In addition to manhandling the 40-pound cases, the pallets themselves were pulled by hand from the top of piles, often resulting in smashed pallets or smashed fingers.

This was the problem which engineers at Mathews Conveyer Company of Port Hope, Ontario, set out to solve some years ago. Warren Raynor, P.Eng., chief engineer for Mathews, was project engineer for the pallet loader development.

Raynor's staff worked for 18 months to produce a working prototype, a fully-automatic machine which filled the gap between the busy bottling machine and the waiting fork-lift truck — completely eliminating the dangerous job of intermediate manhandling up to 900 cases per hour. Their solution resulted in a machine which fulfills its function to perfection, and is an excellent example of the use of every type of mechanical power transmission equipment and controls.

To give some idea of the number of components and materials assembled by the design team into a smoothly operating mechanism, the following is a partial list:

- 9 air cylinders
- 110-volt control unit
- 4 speed reducers
- 4 electric motors
- air-line filters
- 30 precision bearings
- 60-ft. precision chain
- gears
- sprockets
- relays
- timers
- starters
- limit switches
- belting
- brakes
- transformer
- push-button station with select switches

World-wide application

After design, development and testing of the prototype, the first production unit was built and delivered to Labatt's new bottle shop in London, where Mathew's R & D team worked with brewery engineers until it was operating satisfactorily. Since then the pallet loader has been put into full production, and installations have been made from coast to coast in Canada. The Mathews parent company in Elwood City, Pennsylvania, has been making and installing the loaders from Canadian drawings in the U. S. A. and, since 1955, production under

license has been carried out in England by W. C. Pantin of Epping, Essex.

As indicated, the first model was fully automatic, completing the loading of pallets from the bottling line conveyors without manual operation of any kind. However, later experimentation by the R & D staff showed that by using an operator for simple initial carton positioning, a large section of the mechanism could be eliminated, with substantial cost reduction. Since that time, most of the units built and installed have been the semi-automatic version.

Three distinct units

In the Mathews pallet loader there are three basic and distinct units—the empty pallet handling equipment; the full pallet handling equipment; and the carton handling equipment.

In the semiautomatic model, the operator stands on a platform on the top of the machine, where the cartons are received directly from the conveyor system and are rolled by a control belt onto the ball transfer table. Here the operator arranges the individual cartons into rows of three or four, depending on the pattern to be built on the pallet, and a bar pushes the row forward into position on the pallet.

With the first row in place, another row of cartons is assembled by the operator on the ball transfer table and pushed into position against the first row; followed by a third and fourth row, until the pattern of one layer is completed. The operator then pushes a button which withdraws the roller apron supporting the completed layer, allowing the cartons to settle gently on the pallet which is immediately below.

The pallet is then dropped on its elevator the distance of the height of the cartons, and the apron slides back to its original position, ready to receive the next layer. The cycle is repeated for each layer until the pallet is finally stacked, with all operations fully automatic except the arranging of the rows of cartons and the manual control of the apron.

Two-minute operation

Each layer of cartons is arranged in a slightly different pattern, interlocking the cartons as bricks are laid, building a fully stabilized load. In building a pallet of 24-bottle cases, the load usually consists of six layers of ten cases each, for a total of 60 cases. At 40 pounds each, this builds a full pallet weighing 2,400 pounds. The operation of filling a pallet takes about two minutes.

When the pallet is fully loaded, the full pallet lift lowers to the bottom position, depositing the pallet on the discharge chains which move it out of the machine and in position to be picked up by the lift-trucks. An empty pallet is then automatically positioned on the full pallet lift, which rises into position ready for the next load, the first layer of which is already being assembled by the operator.

A stack of ten empty pallets is loaded into the empty pallet handling equipment by means of a fork-lift truck. From then on, feeding of the empty pallets becomes automatic, an empty pallet being fed into the full pallet lift following discharge of the filled pallets.

In the fully-automatic model, controls are set to alter the pattern of each row, and the loader operates without assistance from the operator all day. Both models accept cartons of varying sizes in rotation. Cases of two dozen, one dozen, or half dozen bottles can be loaded on alternate pallets when required, although naturally long runs of the same sizes speed up loading.

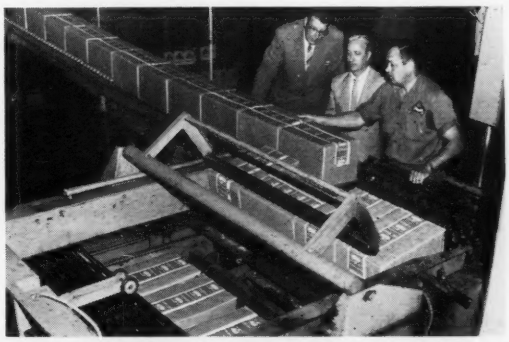
Other numerous applications

The Mathews Company has applied for a series of patents on the pallet loader, which is now being developed for many specialized purposes. The oil industry in particular is finding it useful, with installations for warehousing operations in Canada including Shell, Texaco, British American and Imperial.

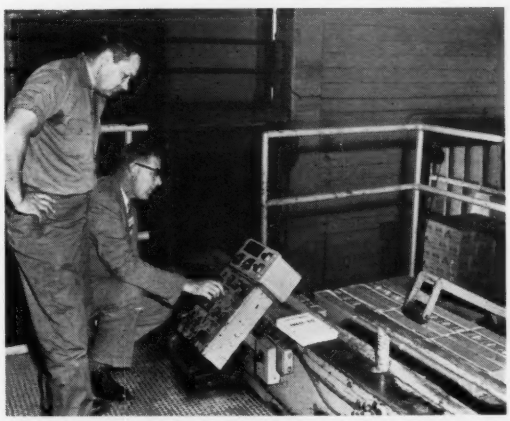
One other R & D project recently completed by Raynor and his staff was the design and development of a unique automatic baggage-sorter to speed up passenger arrivals at the new Air Terminal Building at Dorval. Shaped like a giant hub-cap with a hollow centre, the shallow cone is approximately 30 feet in diameter, with a 12-foot hole in the centre. As the big stainless-steel cone slowly revolves, the baggage emerges from the centre and slides gently down the sloping sides toward the rim, where the passengers pick up their bags as they pass. Seven of these machines will be installed at Dorval.

Raynor and his staff have also designed and developed the new parcel sorting units for the Winnipeg and Vancouver post offices. These 100-foot long tables each has a total of 29 sorting stations.

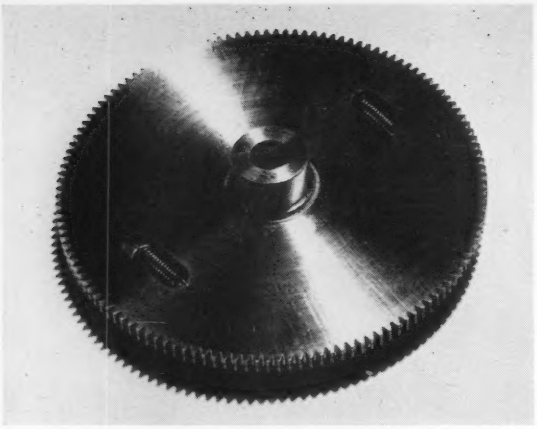
Projects currently on the drafting tables include an automatic de-palletiser, plus automatic warehousing equipment, designed to fill orders punched out on cards without human handling. ★



As the first layer of cartons settles into position on the pallet, the operator positions the second layer.



Warren Raynor (right) who designed the pallet loader, checks the controls.



Backlash in precision gears

Jet age calls for very small tolerances

Winfred M. Berg
President
PIC Design Corp.

In the past five years backlash in precision gearing has become more and more critical to the engineer and to the designer of precise servo-mechanical systems. This is particularly true since the arrival of the jet and missile age.

Servo systems are requiring better accuracy and control due to the tremendous speeds and modes of travel. When our present obsolete gear standards were established they were never designed for today's precise gear cutting mechanisms, machines, inspection and checking equipment.

What is backlash?

Backlash in gears is one of the most misunderstood expressions, yet the principles are very simple. A complete study of backlash must include a discussion of the methods of measurement; inspection and application must also be more clearly defined and understood.

In general, backlash in gears is the play between mating teeth. It occurs only when the gears are in mesh. See figure 1.

Many factors affect physical backlash in a finished gear assembly or servo box. These include:

- gear manufacturing tolerances and variations
- shaft fits
- play in bearings
- pitch diameter tolerance variation
- tooth to tooth spacing variations
- eccentricity in relation to bore

All these points must be taken into consideration and all parts must be manufactured to within very small tolerances to minimize the possible accumulative errors if minimum backlash is to be achieved.

Backlash is provided in designs for a wide variety of reasons. The general purpose of backlash is to prevent gears from jamming together by making contact on both sides of their teeth simultaneously.

Backlash cannot be designated without consideration of the conditions under which the gears will be machined. Any error in machining which tends to increase the possibility of jamming makes it necessary to increase the amount of backlash by at least an amount equal to the possible errors. Consequently the smaller the amount of backlash the more accurate the machining of the gears and other associated components must be. This latter fact is very important. It is useless to specify the finest precision gears if the other components are of lesser precision.

Measuring backlash

Backlash, being the largest distance between non-driving tooth surfaces of adjacent teeth, or the clearance between the teeth of mating gears, is usually measured at the common pitch circle. It varies from .0000 (assuming everything is manufactured perfectly) to .0015 in a pair of Precision 1 gears, depending on the pitch, number of teeth, tolerance variations and the precision class of the gear. So called "zero backlash" application is almost impossible, and very expensive, and should be avoided.

Backlash is often defined as the amount by which a tooth space exceeds the thickness of an engaging tooth. Numerical values of backlash are generally understood to be on the pitch circles.

Backlash can be measured on a variable centre distance fixture similar to that used in checking the composite error and tooth-to-tooth error in gears. In this case the backlash is approximately equal to the change in centre distance multiplied by twice the tangent of the transverse pressure angle.

For example, assuming .0001 centre distance change and 20 deg. pressure angle gears, the backlash is equal to .0001 x 2 x .36397, or .000072 inches.

Gear standards

It is this writer's contention that present gear standards are not exacting enough. According to those standards, backlash is based on two mating gears of like kind measured at maximum and minimum conditions.

What are maximum and minimum conditions? Many inspection departments greatly misunderstand this standard. While it might take only a few minutes to cut the gear, if the inspection standards were followed, it would take days to find the true backlash at maximum and minimum conditions.

Let's refer to figure 2. We mesh tooth 1 of gear A with tooth 1 of gear B and measure and record the backlash. We now mesh tooth 1 of gear A with tooth 2 of gear B, again recording the backlash. We proceed in this way until tooth 1 of gear A has been checked against every one of the teeth in gear B.

We now move to tooth 2 of gear A and proceed to mate it with every tooth in gear B. And so on through the total number of teeth in both gears. It can readily be seen that checking backlash to today's standards can be a very long and tedious assignment, not to mention the expense involved. And if there were a large quantity of gears to be checked, it might be months before delivery could be made.

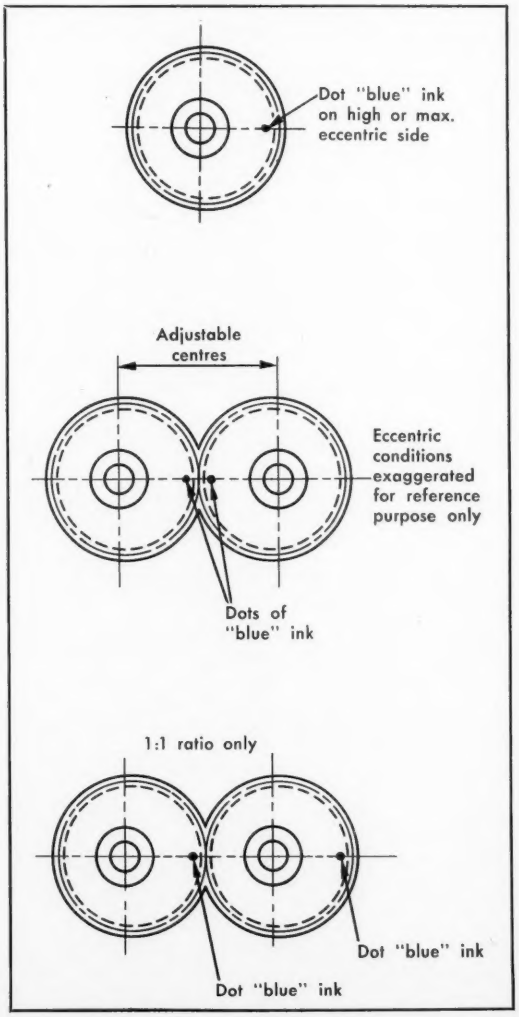
What of the future?

There is some speculation that, with the increasingly exacting backlash requirements, backlash control specifications will include the following:

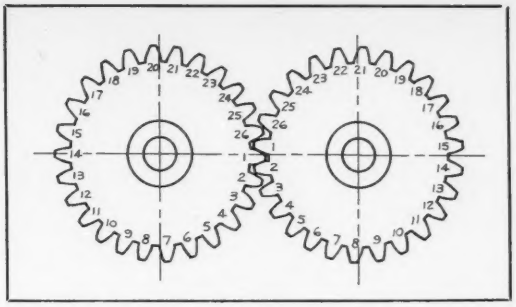
"Mark the high on the eccentric side of the pitch diameter with a dot of blue ink, or permanent mark in the gear."

The main purpose of such marks would be in adjustable or floating centre gears. Here backlash could be minimized by meshing each pair of gears at the known worst or maximum limits.

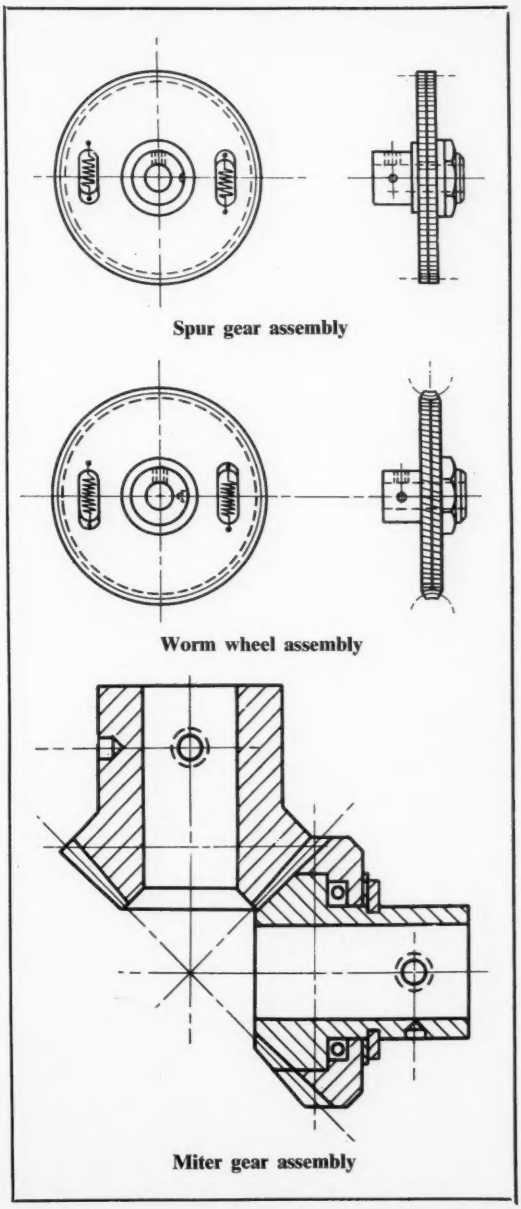
In cases where 1:1 ratios are involved, the gears could be meshed to permit the high spots to cancel out.


Dot "blue" ink on high or max. eccentric side
Adjustable centres
Eccentric conditions exaggerated for reference purpose only
Dots of "blue" ink
1:1 ratio only
Dot "blue" ink
Dot "blue" ink

2. How to allow for eccentricity of gears.



3. Chart for checking maximum and minimum backlash in gears.



4. Special assemblies designed to combat backlash.

continued ▶

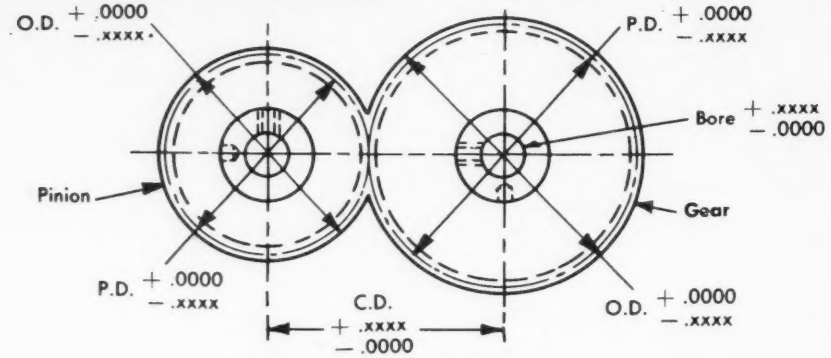
Design Engineering DATA SHEET

Precision Gear Reference Data

C.D. = Center Distance
P.D. = Pitch Diameter
O.D. = Outside Diameter
R. D. = Root Diameter
T.C.E. = Total Composite Error
T.T.C.E. = Tooth-to-Tooth Composite Error

$$\text{P.D.} = \frac{\text{No. of Teeth}}{\text{PITCH}}$$

$$\text{O.D.} = \frac{\text{No. of Teeth} + 2}{\text{PITCH}}$$

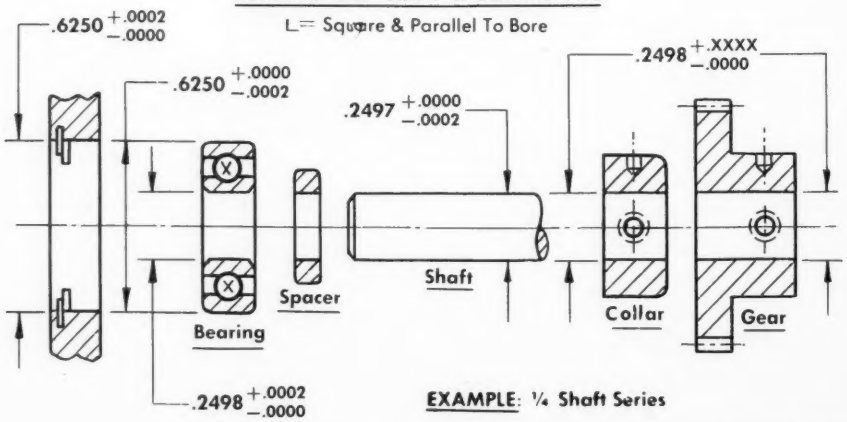


$$\text{C.D. (Nominal)} = \frac{\text{P.D. (pinion max.)} + \text{P.D. (gear max.)} + (2 \times \text{T.C.E.})}{2}$$

RECOMMENDED TOLERANCES

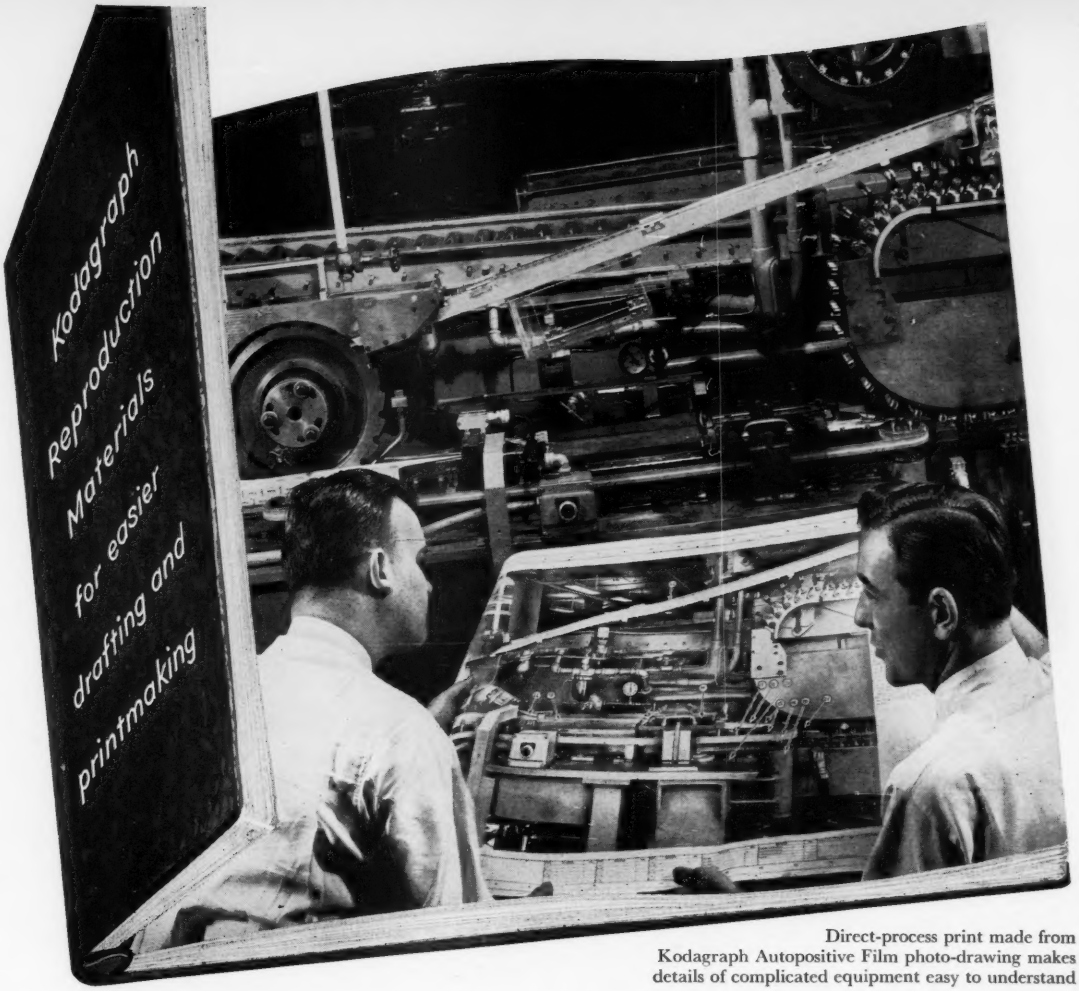
PIC Class Gear	P.D. Tol.	O.D. Tol.	Bore Tol.	C.D. Fixed Centers	C.D. Adjustable Centers	Side Wobble at 1" Rad.	O.D. Concentricity to Bore
Prec. 1	−.001	−.002	+.0005	+.0005	+.002	.001	±.0005
Prec. 2	−.0007	−.0015	+.0003	+.0003	+.0015	.0007	±.0003
Prec. 3	−.0005	−.001	+.0002	+.0002	+.0012	.0005	±.0002
Ultra Prec. 1	−.0004	−.0008	+.00015	+.00015	+.001	.0004	±.00015

RECOMMENDED SHAFT & BEARING FITS



EXAMPLE: ¼ Shaft Series

Chart courtesy PIC Design Corporation



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Design Engineering opinion poll

What do you understand by the term "employee-engineer"?

Opinion Poll is a sampling of readers' views on questions of current interest to engineers. Month by month typical readers chosen completely at random will be polled.

On the face of it, this month's question is hardly controversial enough for an opinion poll, but a new association's moves in Toronto makes it cogent indeed. The fact that some of the people we questioned may have had no knowledge of the new association does not detract from the question.

Gilbert R. E. Pitts, P.Eng.
Brantford, Ont.

In a sense all engineers are employee engineers, since all engineering work is done at the request of some client who pays for the work. However, engineers whose remuneration is dependent on fees received for work done might be eliminated from the employee class. This would leave as employee engineers those who receive a regular salary or wage which does not vary with their actual output.

Other factors, such as authority to hire or fire, or a voice in company policy, may be used to remove an engineer from the employee class.

Thus an engineer is removed from the employee engineer class by a process of elimination, rather than being placed in the class by definition.

W. R. Coulter, P.Eng
Coulter Copper &
Brass Co. Ltd.
Toronto

This term applies to a fully qualified engineer who is employed as an engineer, doing engineering work, for which he receives payment in the form of salary, or salary plus bonus, from an employer organization or corporation, in which he has no significant or substantial interest, financially, in the organization in the capacity of a partner or shareholder.

The "employee engineer" may or may not serve in a management capacity, supervising the work of other engineers, but he would lose his identity as an "employee engineer" if his time were fully spent on supervision or management work, of which only a very minor part was the supervision of engineering type of work.

P. D. Dalton, P.Eng.
Dalton Engineering &
Construction Co. Ltd.
Toronto

An employee-engineer is an engineer employed by a person or firm whose duties or responsibilities are of a nature that require the use of engineering training. If the work involved is of a non-engineering nature then the individual, though an engineer, is not in the proper sense an employee-engineer.

It follows that to be employed by an engineering firm does not in itself make the individual an employee-engineer. It is understood that an engineer is a graduate of a recognized school of engineering and or a member of a professional engineers' association.

D. H. Millard, P.Eng.
Willowdale, Ont.

In the strict sense of the words, anyone who is qualified as a professional engineer and regularly works on a salary rather than a fee basis is an employee engineer. This definition would include a wide range of positions, from general manager of a large company to personnel officers, sales representatives, editors, writers, teachers, and market analysts, to mention a small part of the list.

To be useful, the definition must select from this broad group the largest number of engineers who have common interests and common problems, I suggest, therefore, that an employee engineer:

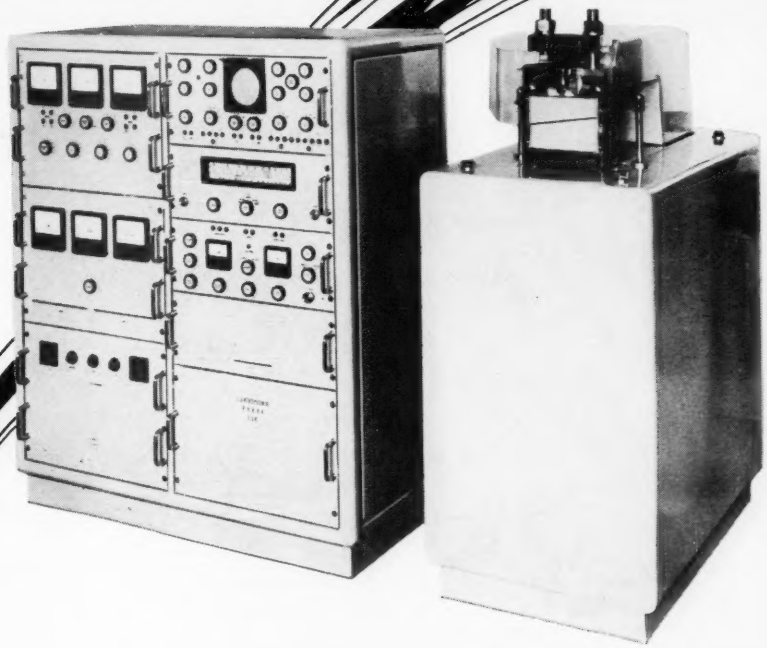
(a) is qualified as a professional engineer and regularly employed on a salary basis.

(b) is engaged for a reasonable proportion of his time, say 50% or more, on duties such as research, testing, design, or construction, which involve use of technical knowledge and judgment.

(c) is not in a position to hire or discharge other professional engineers.

The common interests and problems of this group are very similar to the interests and problems of the more general category of the employee professional, a subject that has been receiving considerable attention in the United States during the past year or two.

TURBO 4
Apparatus



A self-oscillating vibration apparatus designed for fatigue testing of mechanical components and turbine blades.

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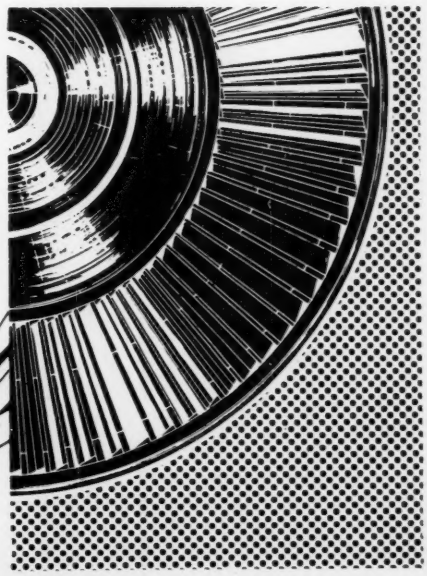

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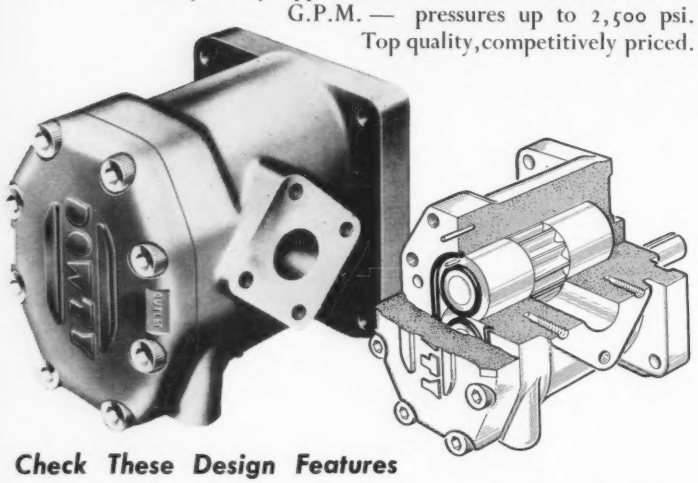

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Size 2	500 to 2500	up to 19.9	18.2	11
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Briefs

Who said exhibitions don't pay off? Taking stock of their recent New York show, Britain finds these immediate trade results: Two pilot installations of banknote counting machines, more cars sold than at the Auto Show held in New York earlier in the year, sale of equipment for accelerated freeze-drying of foodstuffs, sales of cigaret-making machinery, a firm enquiry for three tons monthly of a high quality steel so expensive it's sold by the ounce, dozens of hard enquiries at the plant-planning exhibit, several leads from companies wishing to set up plants in Britain . . .

Talking of new plants, an unprecedented panel at an Industrial Building Exposition to be held in December will reveal how du Pont determines what new type of plant is best for its needs. Panel will consist of four company engineers. Date, December 12 to 15, place, Coliseum, New York.

Other forthcoming events for your diary: technical sessions of American Society of Tool and Manufacturing Engineers, Ambassador Hotel, Los Angeles, November 14 to 18; symposium on stereochemistry in organic reactions, held by Chemical Institute of Canada, University of Alberta, Edmonton, September 6 and 7; annual meeting of Gray Iron Founders' Society, Netherland Hilton Hotel, Cincinnati, October 12 to 14; plastic exposition, New York's Coliseum, June 5 to 9; convention and exposition of the Association of Iron and Steel Engineers, Cleveland Auditorium, September 27 to 30; Century 21 exposition, the first international exposition in the U. S. since 1939, Seattle, Wash., April 21 to October 21, 1962; annual convention of the American Society of Civil Engineers, Statler-Hilton, Boston, October 10 to 14.

Ever have trouble lighting a cigarette while driving? Japanese company has designed a dashboard case which releases a lighted cigarette. More than 40 patents have been taken out in 13 countries, warns the inventor . . .

Another device for your car: a clothes vacuum to ensure that you're neat when you step out. Invented by Toronto industrial designer Allan Gladwell, it operates off windshield wiper suction, costs $5. **And a couple** of Belleville, Ont., inventors have come up with a detergent-impregnated dishcloth designed to help housewives who never know how much detergent to use for dishwashing . . .

Suggestion to Toronto PR firm which handles publicty for British industry: Either buy a typewriter with £ sign or convert sterling to dollars. We hate your makeshift symbol, letter L with a dash through it . . .

New York manpower firm which made a survey of executive openings in smaller firms found that engineering executives were third on the most wanted list, after sales chiefs and manufacturing/production heads. Twenty-two percent wanted engineering executives, fractionally more than the ratio determined in a survey of companies of the same size six months earlier. However, the odd thing is that companies polled felt that executive engineers (39.5%) were harder to find than sales (31.2%) or manufacturing/production heads (17.2%). Earlier survey showed sales placements (34%) presenting the biggest problem, with engineers (28%) second and manufacturing people (19.8%) next in line.

From Britain comes news of a product which we should have thought of first. It's a "snow locust," a device which fits on a vehicle to disperse snow by melting. It directs heat from oil burners onto the snow, each burner having a variable heat output of from 40,000 to 120,000 Btus at a temperature of 1,200F. Only two men are needed to handle the equipment, which deals with snow up to seven feet deep.

Another ingenious British machine which we could do with here is an automatic handling and sorting machine for timber. Claimed to be in advance of anything similar anywhere in the world, it sorts the timber into batches of various lengths and delivers the batches, steel banded for loading, on trucks. It can also "stick" the timber (insert lengths of wood crosswise to allow air to circulate) without reducing speed. It can handle 28,000 pieces of timber a day. The machine is 240 ft long, employs the latest techniques in hydraulic and electronic controls, and requires a team of 14 men, though it does the work of 60.

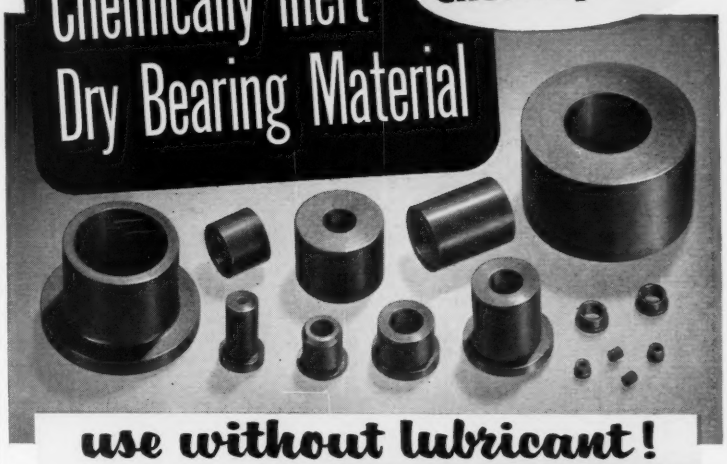
Somewhat belatedly a Canadian firm has revealed that it supplied a pocket paging device to the recent Democratic convention. The device made it possible to summon delegates and officials at crucial moments in the proceedings, no matter where they were. The device, actually a closed-circuit radio, was carried in the pocket, each receiver having a separate wavelength.

Interesting patent case has been carried a stage further in U. S. courts. The issue is whether AMP Inc., of Harrisburgh, Penna., has a right to patent on its bolt-cutting tool. Company brought a charge of patent infringement against a competitor. A district court dismissed the charge and declared that the patent itself was invalid because of the obviousness of the invention. AMP appealed on the grounds that its tool represents the first and only significant breakthrough in bolt-cutting techniques. The U. S. Cir-

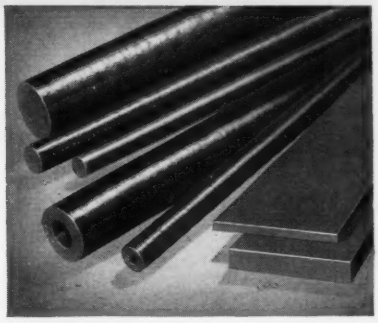
(Continued on page 88)

Chemically Inert Dry Bearing Material

Chemloy 719



use without lubricant!



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. . . because it is impervious to practically all known chemicals, solvents or corrosives.

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An item from
The Design Show

New idea in bronze bushed bearings

Designed for easy replacement, no special tools required

Development of a bronze bushed bearing that can readily be replaced without complete dismantling of a machine has long been one of the targets of design engineers. One new simple, yet very effective solution appears to have been found.

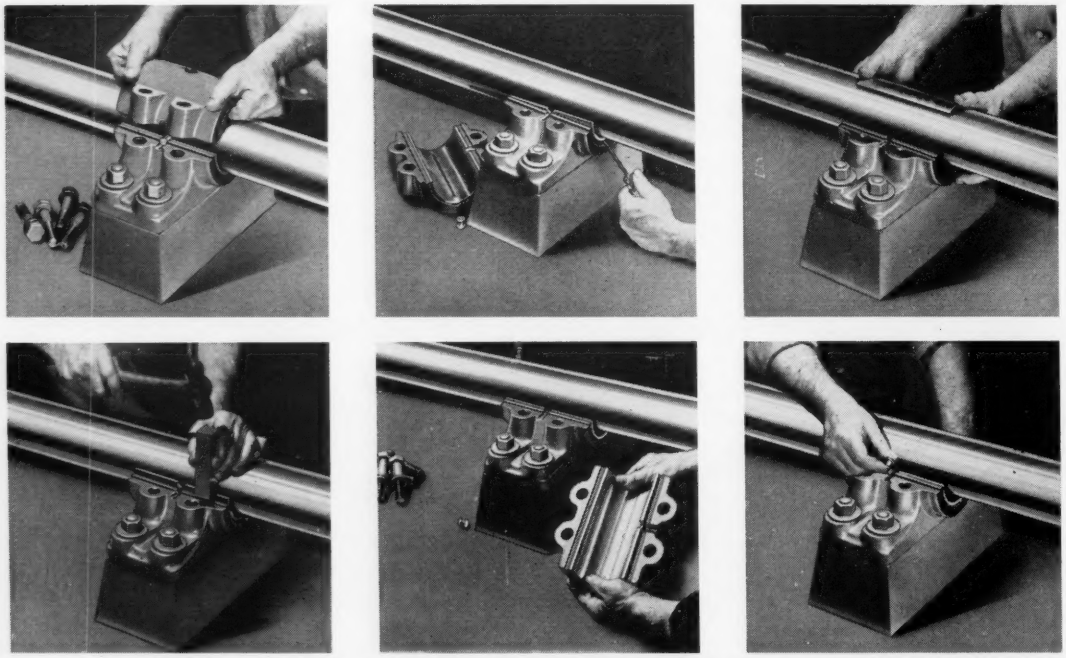
This new idea in bushed bearings minimizes the loss of downtime and the hard work usually associated with replacing these parts. Six simple steps, as illustrated and described below, take care of the replacement operation. And the only tools required are a screwdriver and a wrench.

This unique design, which your DE editors saw for the first time at the 1960 Design Engineering Show held in New York, has been developed by the Dodge Manufacturing Corporation, of Mishawaka, Indiana. They are being marketed in Canada through the Dodge associates, United Steel Corporation, of Toronto.

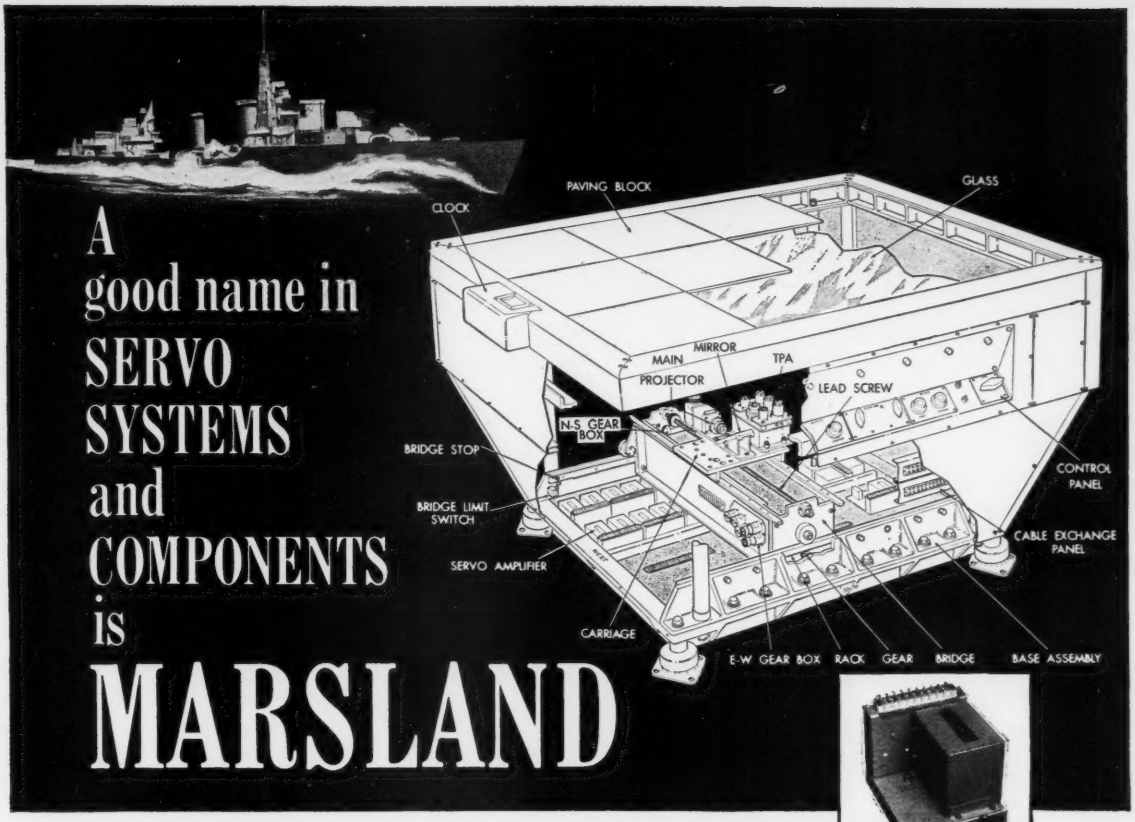
Chief features of the design include:

- Only the top half of the housing need be removed during replacement of the liners.
- The bronze liner is in two parts. They are machined from cast cylinders of leaded bronze alloy. Special alloys for high temperatures and corrosive conditions are obtainable.
- The housing is rugged semisteel to withstand heavy shock loads. Ductile iron or steel can be supplied.
- Bearing ends are machined to take thrust.
- No screws are needed. Rotation of the liner with the shaft is prevented by a patented brass retainer spool which is recessed between the cap and the base of the housing.
- Tongue and groove joints prevent the bearing cap from shifting along the shaft.
- Grease groove provides for distribution of lubricant.

If you have been looking for an easy replaceable design of bushing, this might set you on the track to a satisfactory solution.

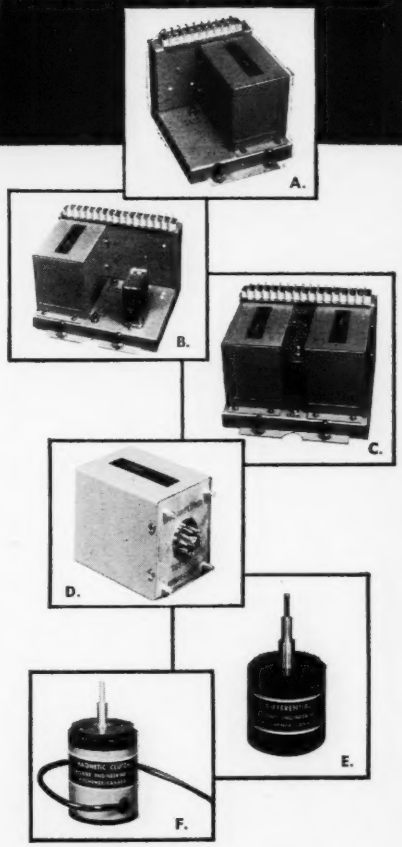


Six steps in replacing liner in Dodge bronze-bushed pillow block: 1. Remove the cap; 2. Raise shaft slightly, pry worn liner loose with screwdriver; 3. Hold base liner against shaft, rotate liner and remove; reverse process to insert new liner; 4. Centre line, top into place; 5. Pry out cap liner, replace by thumb pressure; assembly will seat liner; 6. Put brass spool in place to prevent rotation of bushing, lower shaft, bolt on cap.



This precision electro-mechanical-optical computer, used to display the geographical position of a ship and its target satellites, is a current system design by Marsland. From a statement of requirement to a design concept, to a working prototype and to approved production assemblies, Marsland engineers servo-systems meeting the most rigid specifications.

Wide experience and comprehensive facilities enable Marsland to manufacture most of the various system components.



A. Transistor Servo Amplifier, Mod. AM-103. *Application:* Single channel, 400 c. synchronous positioning servo loop. Up to size 18 Bu. Ord. motor, with built-in 400 c. power supply and feed-back damping control.

B. Transistor Servo Amplifier, Mod. AM-102. *Application:* Two channels, 400 c. precision positioning servo loop, (i.e. Resolver). Up to size 18 Bu. Ord. motor, built-in 400 c. power supply, transfer input network, feed-back damping and stick-off voltage controls.

C. Transistor Servo Amplifier, Mod. AM-101 (AM-104 + AM-105). *Application:* High gain, 400 c. synchronous amplifier for highest accuracy velocity integrating servo-loop, using up to size 18 Bu. Ord. motor/tachometer generator. *Built-in:* power supplies, null voltage suppressor, tachometer generator phasing network, speed adjustment and quadrature rejection circuit.

D. Transistor Amplifier, (Pre-Amplifier) Mod. AM-104. *Class A*, all transistor voltage and low power amplifier combined. Voltage gain between rated impedances is adjustable between 50 and 150 V. Built-in power supply, 400 c. (Power Amplifier AM-105 packages in same manner: *Class B*, all transistor synchronous power amplifier-application as positioning and integrating servo amplifier.)

E. Differential, Model M-134. *Body and Mounting:* Similar to size 18 Bu. Ord. motor. All ball bearings. *Application:* Servo mechanisms and computors. *Speed/Torque:* symmetrical mechanical differential max. speed of any shaft 4000 r.p.m.; max. torque output 10 oz. inch.

F. Magnetic Clutch, Model M-133. *Body and Mounting:* Similar to size 18 Bu. Ord. motor. All ball bearings. Max. speed 4000 r.p.m. *Application:* Servo mechanisms and computors. Energizing Power: 24 V.D.C., 3 watts. *Min. Torque:* 35 oz. inch.

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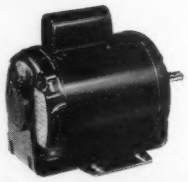

RBR-2 (large illustration) split phase 1/6 to 1/3 H.P. 48 frame.
RKR-2 (small illustration) Capacitor start ½ and ¾ H.P. 56 frame.
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Briefs—*continued*

cuit Court of Appeals in Chicago reversed the earlier judgment, saying that the AMP device "made a significant contribution to the mechanical art by providing the first device in history capable of cutting bolts and screws without damaging their threads."

This and that: **A Japanese** company is marketing what is said to be the world's first low temperature fluxless solder . . . **the term** "pig" has been abandoned as a designation for primary aluminum products . . . **Continental Can** has developed a polyethylene nozzle with a permanently attached cap, designed to increase the filling and closing speeds of oblong nozzle-type cans . . . **scientists at IBM** have achieved a new method of forming semi-conductor crystals in one continuous operation rather than many . . . **Heintzman plans** a piano with interchangeable cases, so you can change the style when you redecorate . . .

Talepiece: If they keep adding special "weeks" and "months" it won't be long before we run the gamut from Aardvark ("Be Kind to the —") to Zither ("Play the — ") weeks. We note that in November alone there are over a dozen, including the following: Cat Week, National Kleenex Week, Young Canada's Book Week, National Downtown Week, National Restaurant Month and Latin-American Week. It seems to us high time that engineers started promoting good causes too: For instance, how about More Pay for Engineers Week and Be-Kind-to-Your-Draftsman Week and More Pay for Engineers Month and Small Plastic Parts Week and More Pay for Engineers Year. . . ?

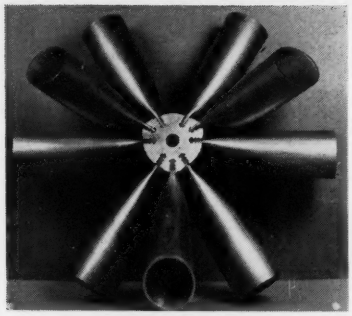
Letters to the Editor

The Triodetic system is unique

Dear Sir,

In your August issue you carry a comment by J. H. Crisp of Montreal suggesting that the Triodetic system displayed at the New York Design Engineering Show is similar to some American developments.

We should like to point out that the unique features of the Triodetic system — which has no counterpart anywhere in the world — is a hub connection (see photograph). This remarkable connection permits the development of many types of con-



struction. It features an extruded hub which receives framing elements directly with much better strength efficiencies than welded, bolted or riveted joints.

The American systems referred to by Mr. Crisp relate to particular structural configurations (simple space frames), and it should be noted that these and any other space frame configurations can be constructed more easily and more economically with the Triodetic connection than by any other connection developed. Although space frame geometrics have been developed in several countries, practical space frames have rarely been built, primarily because of the lack of simple, efficient connections.

Clarence F. Fentiman,
President,
F. Fentiman & Sons Ltd.
Ottawa.

Wants reprints

Dear Sir,

One of our members has sent me a photostat of the editorial appearing on Page 100 of the July issue of Design Engineering.

I agree with much that you have stated and I am wondering if it will be possible to get 80 reprints of this page to send to the members of our Association.

I would also be interested in seeing a copy of the July issue of your magazine inasmuch as the Fluid Power Industry has been featured therein.

One of these days I am going to write you about the new Fluid Power Society which the National Fluid Power Association is sponsoring, as I feel there is very fertile ground for chapters in Toronto and elsewhere in Canada.

Barrett Rogers
Executive Vice-president
National Fluid Power Association.
Milwaukee, Wis.

(Sorry, the demand has been heavy and we have only 30 reprints left. They have been sent to you with our compliments. —Ed.)

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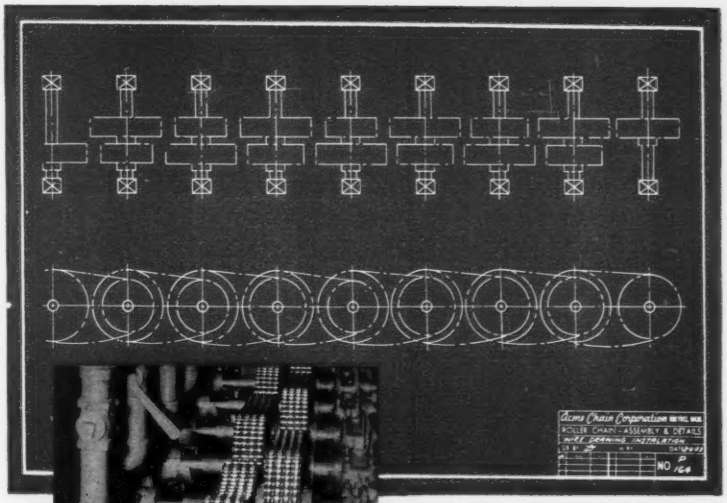

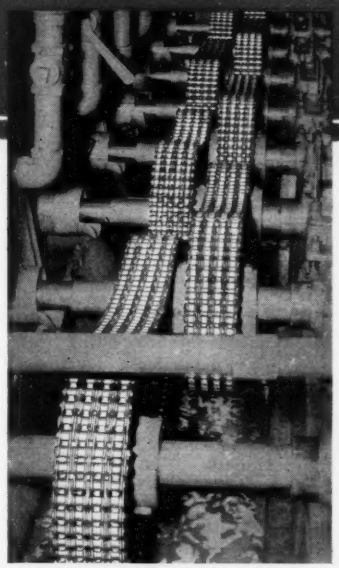

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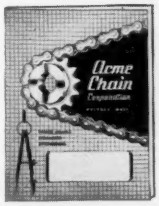
Over 40 years' experience in scientific engineering research are embodied in the manufacture of ACME Roller Chains. The selective steel analysis for each chain part is based on bringing out the best physical qualities obtainable for strength, endurance and long life.



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How to select high speed bearings

Factors are mounting, alignment, lubrication and fitting practice

L. W. McKee
Chief Product Engineer
The Barden Corporation

At extreme speeds, bearing selection, mountings, alignment, lubrication and fitting practice become very critical to a point where conventional mounting practice will no longer assure reliability and long life. This discussion, condensed from a speech presented to an SAE seminar, is intended as a guide to the designer to enable him to properly select and apply bearings for this type of service.

Selecting the right bearing for any given application is not always an easy assignment. Factors of speed and temperature require special consideration. Generally speaking, the higher the speed and/or the temperature, the greater the need for design which will favor the bearing.

Angular contact bearings will run at speeds to DN=1,500,000 and higher in the larger sizes with the proper selection of retainer material and design. The angular contact bearing lends itself to extreme speeds better than any other bearing type because the retainer can be very light in weight and of one-piece construction without rivets or other fastening devices. They can support radial and undirectional thrust loads.

Deep groove bearings are generally limited to speeds of DN=1,000,000 because of the heavier retainer and weakness of fastening devices. They can support radial and thrust in either direction but have less capacity than angular contact bearings.

Roller bearings can also be operated at high speed, but in most applications the roller bearing dictates that a deep groove ball bearing be used on the other end of the shaft to take two-directional thrust rather than an angular contact with its greater speedability. Also in many applications the radial clearance of the roller bearing plus the fact that it does not apply thrust to take up clearance in the ball bearing limits ability to balance to close limits.

AFBMA (Anti-Friction Bearing Manufacturers Association) life computations do not take into account centrifugal ball load effects at extreme speed and in cases where DN exceeds 800,000, the life computations become more involved and bearing selection should be confirmed by the bearing manufacturer. Catalog ratings can however be used as a guide if bearings are selected conservatively.

Bearing materials

Temperature limitations of the materials commercially used in high speed accessory ball bearings are outlined in the accompanying table.

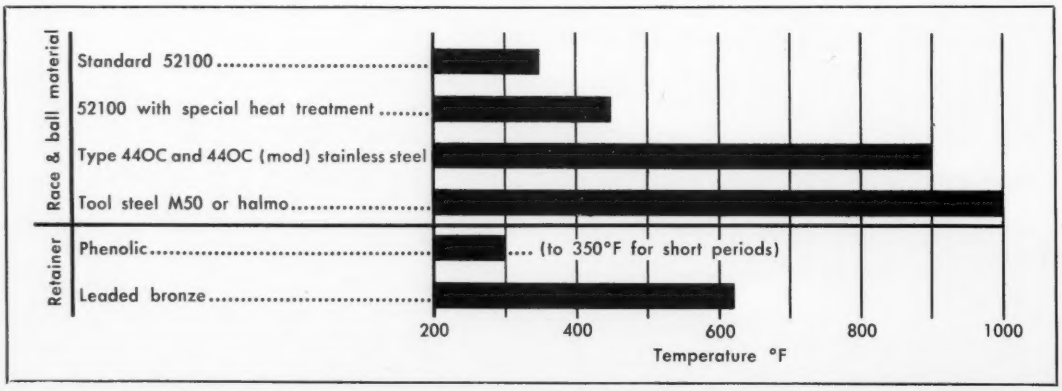
Generally 440c is satisfactory in most applications over 450F and is desirable because it is more available and is relatively clean without resorting to vacuum melting. It has less catalytic effect on lubricants and is relatively easy to machine and grind.

Tool steels such as M50 offer more capacity at high temperature because of their better hot hardness. Barden test results and field experience indicate leaded bronze to be the best retainer material within the temperature limitations of present day lubricants.

Lubrication

At high speed and/or heavy loads, oil must be used to remove heat from the balls and retainers as well as to lubricate. Jet or spray systems do this better than oil mist systems.

Note that jet or spray systems permit higher temperature limitations than air-oil mist. This is because at elevated temperatures the air in the mist system



1. Chart of allowable operating temperatures for some standard high speed bearings.

continued
page 92

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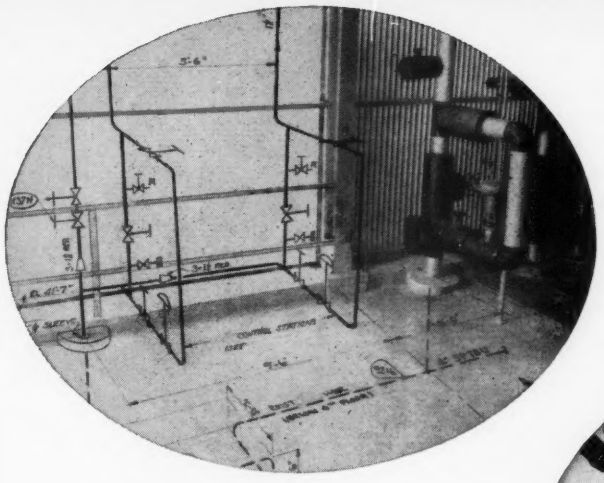

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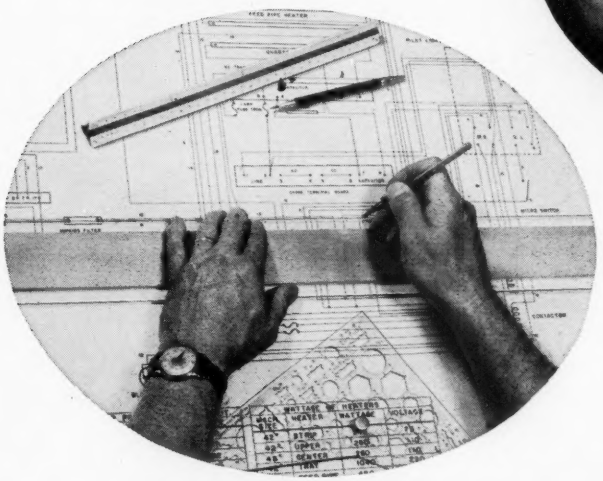

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High-speed bearings *continued*

oxidizes the oil to form sludge.

Recommended oil quantity is as follows:

METHOD OF APPLICATION	OIL QUANTITY —cc/min	LOAD CONDITIONS
Air-oil mist	.1 D to .5 D	Light to moderate
Jet or spray	5 D to 15 D	Moderate to heavy

where D=bore in millimetres

Mounting arrangements

The wick system, see figure 2, features symmetry for equal oil flow to both bearings, a spring to maintain thrust on the angular contact bearings, a spring follower to maintain good outer ring alignment, serrated slingers to draw oil through bearings (also slingers remove heat from the inner race), and ramps in the spring followers to assure that the oil will go through the bearings. At high speed, oil will leave the shaft tangentially at the wick and will not travel along the shaft.

Figure 3 shows the proper aiming of an oil jet. Note that the oil is directed to the space between inner race and retainer.

Figure 4 shows oil fed through the shaft. Note how oil is forced to travel through the bearing.

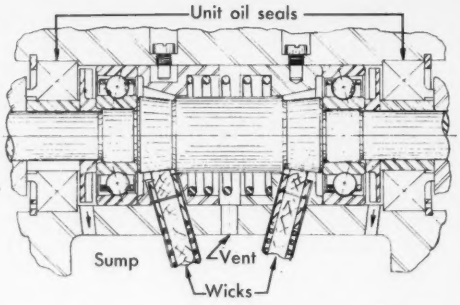
Fitting practice

Shaft fits should be tight. Generally .00005 tight to .00035 tight is recommended for most applications. Clamping of inner races is essential as a temperature differential between inner race and shaft could otherwise cause looseness and poor heat transmission from the inner race (a heat source) to the shaft.

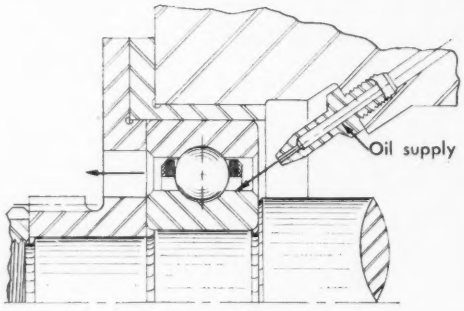
Housing fits should be loose. Generally .0001 to .0005 loose is recommended for most applications. The outer race of at least one of the two bearings must be free to slide to avoid overload or zero thrust as the shaft expands with heat. ★

General rules for high-speed high-temperature bearing operation

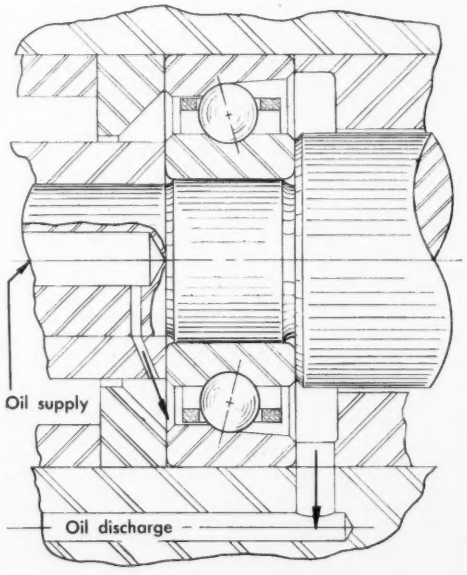
1. Be sure the bearing has enough radial play to allow for radial expansion of the shaft with respect to the housing.
2. Do not solidly preload one bearing against another. Centrifugal ball loads and differential expansion almost invariably lead to failure with solid preload.
3. Balance to close limits. Unbalance loads must be included in life calculations and generally should be less than 1/10 of the load rating at speed.
4. Watch out for critical speeds in the operating range. Bearings will run at or near a shaft critical provided the critical is at a low speed, or if time at critical is short. The effect of operation at critical speed on bearing performance is unpredictable, however, and it is therefore best to keep it well above the operating speed even though with a good design, it is sometimes scarcely noticeable.
5. Spring preload is normally recommended. It should be around 1/3 to ¼ the bearing capacity at speed.



2. Wick system of lubrication



3. Oil jet lubrication



4. Lubrication oil through shaft

Comparison of three methods of lubrication.

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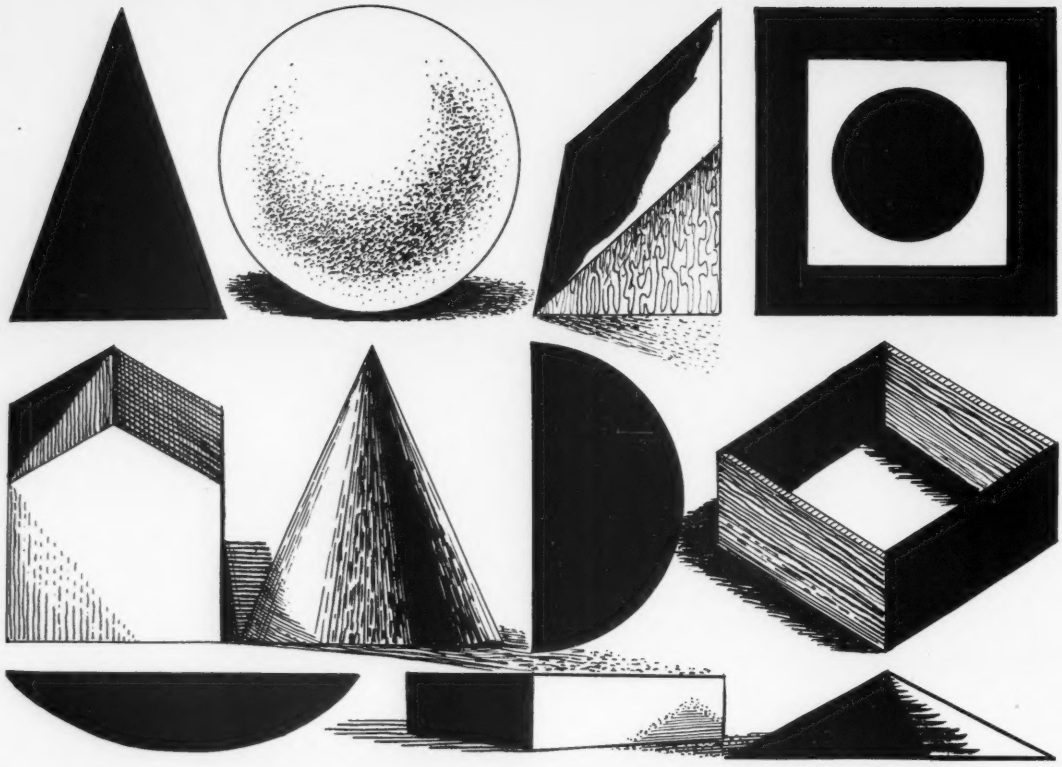


Shortcuts to maxima, minima problems

Partial differentiation reduces calculations; it's easier than it sounds

W. H. Sheppard, B.Sc.

One of the most useful applications of the differential calculus is in the determination of maxima and minima, but in the solution of practical problems the best approach is not always known. For example, it is not usually appreciated that partial differentiation (which is not as difficult as it sounds) may shorten the calculations.

This article discusses the best method of solving problems in maxima and minima and evolves certain new principles. The chief problem considered is the economical use of sheet metal, and examples of tent construction (ever popular in the teaching of differential calculus) are included because they help in a grasp of the fundamentals. The methods given can readily be applied to the more difficult engineering problems dealing with rates of flow, heat transfer and so forth.

A few simple problems are considered first, applying ordinary differentiation. Partial differentiation is then used to derive a special formula for a simple type of problem and then is applied to more difficult examples.

Problems in sheet metal may be divided into two broad classes:

(a) to cut the greatest capacity container from a given blank, and
(b) to design the greatest volume container for a given surface (or conversely, the least area for a given volume) irrespective of the blank used. Before tackling any problem of this nature, it should be clear which is required.

I. GREATEST VOLUME FROM GIVEN BLANK

Rectangular box

Consider a rectangular sheet (figure 1), with the corner cut out and the sides bent up to form a box. It is required to determine the dimension 'x' of the square cutaways to give the greatest volume of box. Using the ordinary methods of the differential calculus,

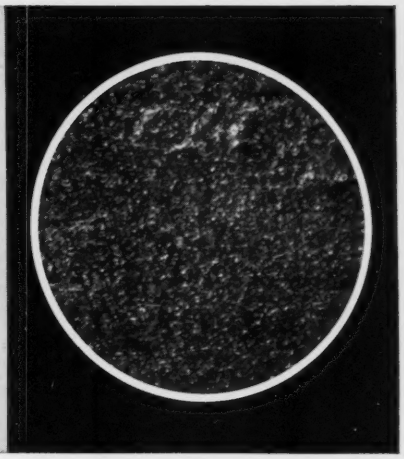
$$\text{Volume } V = x(a - 2x)\,(b - 2x)$$
$$= 4x^3 - 2(a + b)x^2 + abx$$
$$\frac{dV}{dx} = 12x^2 - 4(a + b)x + ab$$

equating to 0, and treating as a quadratic,

continued *page 96*

Photomicrograph, 300x magnification, shows coating structure produced by conventional phosphating treatment.

Fine-grained coating, shown in photomicrograph at 300x magnification, produced on steel by Bonderite 890.



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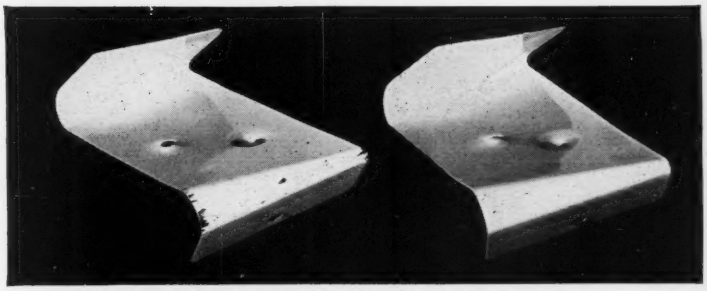

Steel panels, finished with an acrylic enamel and bent on a conical mandrel. Unretouched photos show paint flaking over conventional phosphate treatment (left), and excellent paint retention over Bonderite 890 (right).

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$$x = \frac{1}{6}\left[a + b \pm \sqrt{a^2 - ab + b^2}\right]$$

the negative root being applicable for a real box.

For a square box, $a = b$ and $x = \frac{a}{6}$

Cone

Consider a cone formed from a circular blank, figure 2. The radius R is constant and either θ, r or h may be regarded as the variable.

$$\text{Volume, } V = \frac{1}{3}\pi r^2 h$$

$$= \frac{1}{3}\pi r^3 \cos^2\theta \sin\theta$$

$$\frac{dV}{d\theta} = \cos\theta(\cos^2\theta - 2\sin^2\theta)$$

equating to 0,

$$\tan^2\theta = \tfrac{1}{2}$$

$$\tan\theta = \tfrac{1}{2}\sqrt{2} = 0.707 \text{ or } \cos 2\theta = \tfrac{1}{3}$$

$$\therefore \theta = 35°16'$$

Using the variable r or h gives the same result for about the same amount of calculation.

II. GREATEST VOLUME FOR AREA USED

In problems of this type (unlike those in the previous section) either the area or the volume must be regarded as constant and this may lead to considerable difficulty.

Rectangular box

Assume a square plan shape, height 'h', length and breadth 'y'.

$$\text{Volume } V = y^2 h$$

$$\text{Surface area } A = y^2 + 4yh, \text{ whence } h = \frac{A - y^2}{4y}$$

$$\text{Substituting } V = y^2\frac{A - y^2}{4y}$$

$$= \frac{1}{4}(yA - y^3)$$

differentiating,

$$\frac{dV}{dy} = \frac{1}{4}(A - 3y^2)$$

equating to 0, V is a maximum when

$$y^2 = \frac{A}{3} = \frac{1}{3}(y^2 + 4yh)$$

$$\text{whence } h = \frac{y}{2}$$

The box is thus half a cube.

Cylinder with closed ends (Figure 3a)

$$\text{Volume } V = \pi r^2 h$$

$$\text{Surface Area } A = 2\pi rh + 2\pi r^2$$

$$\text{whence } h = \frac{A - 2\pi r^2}{2\pi r}$$

Proceeding in the same manner as the previous example, V is a maximum when $h = 2r = D$

Cylinder with an open top (Figure 3b)

In this case $A = 2\pi rh + \pi r^2$

Proceeding as in example above, V is a maximum when $h = \frac{D}{2}$

The open cylinder thus has half the depth of the closed type.

Cone with an open end (Figure 3c)

$$\text{Volume } V = \frac{1}{3}\pi r^3 \cot\theta, \text{ where } \theta \text{ is the semi-vertical angle of the cone.}$$

$$\text{Surface area } A = \pi r^2 \operatorname{cosec}\theta, \text{ and } r = \left[\frac{A}{\pi}\sin\theta\right]^{\frac{1}{2}}$$

$$V = \frac{\pi}{3}\frac{\cos\theta}{\sin\theta}\left(\frac{A}{\pi}\right)^{\frac{3}{2}}\sin^{\frac{3}{2}}\theta$$

$$\frac{dV}{d\theta} = k(\sin^{\frac{1}{2}}\theta\sin\theta + \tfrac{1}{2}\cos\theta\sin^{\frac{1}{2}}\theta\cos\theta)$$

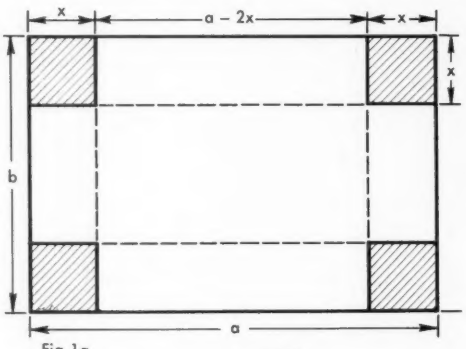

Fig. 1a

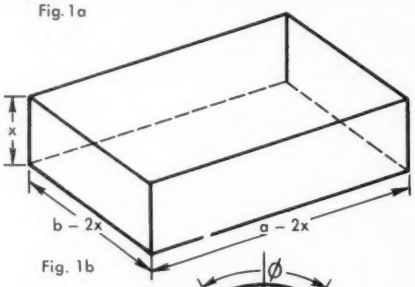

Fig. 1b

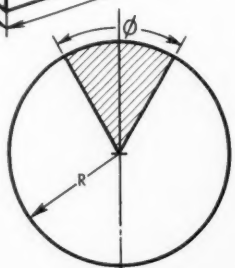

Fig. 2a

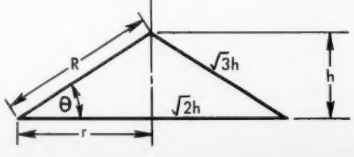

Fig. 2b

continued *page 98* ▶

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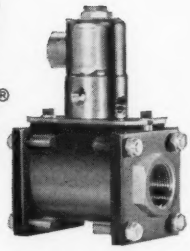

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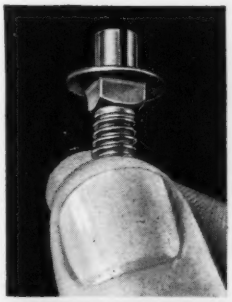

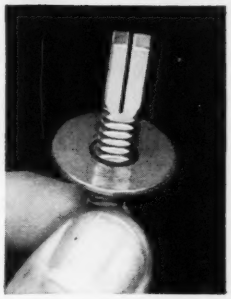

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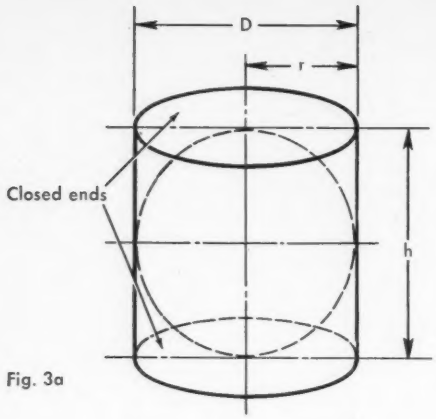


Fig. 3a

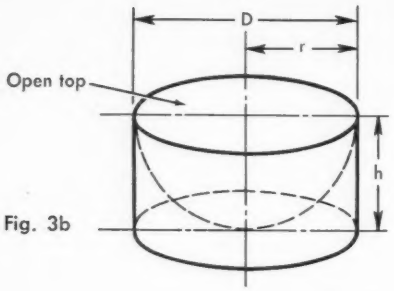


Fig. 3b

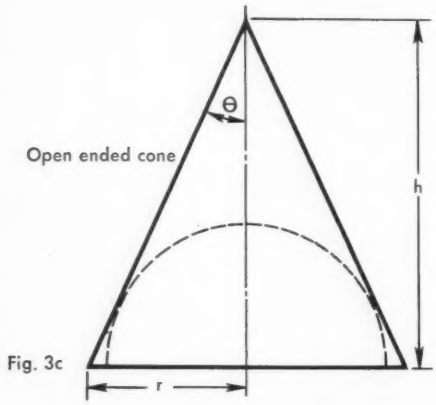


Fig. 3c

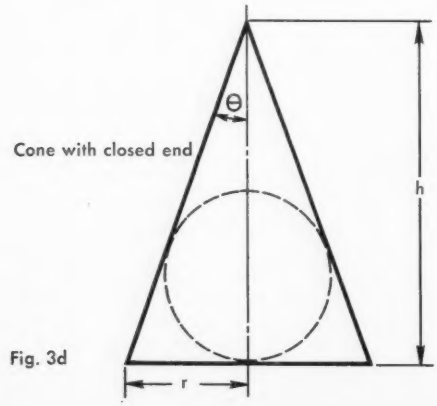


Fig. 3d

$$\text{when } \frac{dV}{d\theta} = 0, \frac{1}{2}\cos^2\theta \sin^{\frac{1}{2}}\theta = \sin^{\frac{3}{2}}\theta$$

$$\frac{1}{2}\cos^2\theta = \sin^2\theta$$

$$\tan\theta = \frac{1}{\sqrt{2}}$$

$$\text{and } \theta = 35^\circ\ 16'$$

This is the angle of isometric projection and it follows that this is the cone that would fit into the angle formed by three mutually perpendicular planes.

Cone with closed end (Figure 3d)

$$V = \frac{\pi A^{\frac{3}{2}} \cot\theta}{3\pi^{\frac{3}{2}}(1 + \text{cosec}\ \theta)^{\frac{3}{2}}}$$

$$A = \pi r^2 + \pi r^2 \text{ cosec } \theta$$
$$= \pi r^2(1 + \text{cosec } \theta)$$

Proceeding as in the previous example gives

$$\text{Sin } \theta = \frac{1}{3}$$

$$\text{and } \theta = 19^\circ\ 27'$$

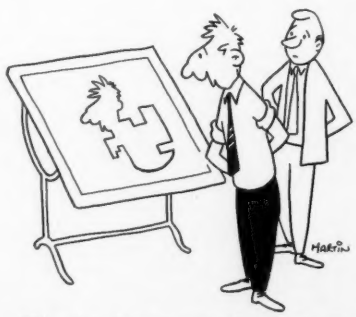
Square pyramid

Similar calculations give $\theta = 35°16'$ for an open-ended pyramid and $\sin\theta = \frac{1}{3}$ for a closed pyramid. It follows that any regular pyramid may be regarded for these purposes as a cone with the inclination of the sides as so calculated.

General note

Considering the results obtained above, it will be observed that, for totally enclosed volumes, the surfaces (or elemental areas in the case of curved surfaces) touch an imaginary sphere at their centres of area. For open ended volumes they may either be regarded as half a totally enclosed volume or considered to touch a hemisphere with diametrical plane at the open end.

This article will be continued in a future issue of Design Engineering.



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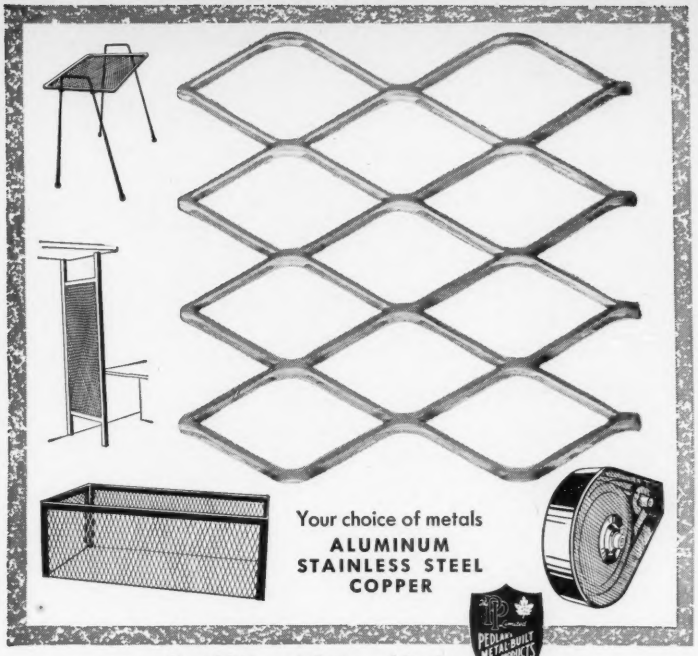

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power transmission

New/products and materials

Marine transmissions

A new line of marine transmissions has been developed for use with high speed gas engines tp to 500 cu in. and high speed diesels up to 340 cu in. Ruggedly constructed for heavy service in the West Coast fishing fleet, the unit runs in an oil bath, and reduction is cooled by an external water jacket. Easthope Bros. Ltd.

Circle 309 on Reader Service Card

Speed drives

Relay panels, rectifier panels and control panels are designed as individual units and mounted separately in a new line of adjustable speed drives. This modular construction permits prewiring and prestocking of a wide variety of chassis to meet different specifications. Cleveland Machine Controls Inc.

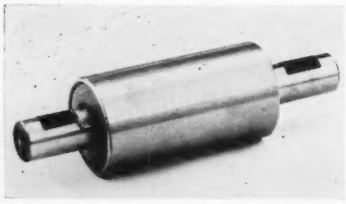
Circle 310 on Reader Service Card

"Any speed" transmissions

A new transmission converts any constant speed input power into an infinitely adjustable output speed. One or more adjustable speeds can be preset in one or both directions up to 1,650 rpm. Designed for applications of one hp or less, the units consume power only in proportion to work performed. No restricted flow or directional control valves are used. Oilgear Co.

Circle 311 on Reader Service Card

Shaft bearing



A shaft bearing assembly has a life expectancy several times that of conventional roller, ball or needle bearing devices. Quieter running and never in need of re-oiling, it is recommended for applications where bearing noise or conducted resonances are problems, as in packaged air conditioners or sheet metal ductwork, and in locations with high ambient humidity or abrasive atmospheres, as in home laundry equipment and industrial sanding or exhaust equipment. The absence of internal vibration also makes the bearing suitable for use in belt sanders and other power tools. The sealed bearing has a lifetime recirculatory oiling system, won't leak and is highly resistant to invasion by dirt or moisture. A base life of 20,000 hours is predicted. Tann Bearing Co.

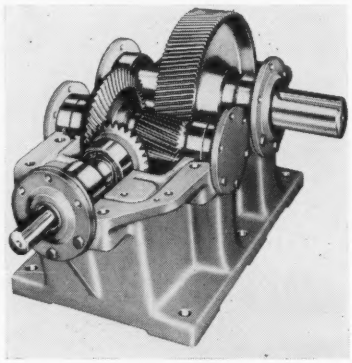
Circle 312 on Reader Service Card

Heavy-duty transmission

A new heavy-duty version of a front-end loader transmission is designed to handle 350 net foot pounds of engine torque, while at the same time permitting increased hydraulic horsepower for bucket operation. A special new three-element torque converter has been developed that will provide high torque multiplication coupled with high efficiency for the most profitable operation. Allison Division, General Motors.

Circle 313 on Reader Service Card

Speed reducer



A new line of spiral bevel speed reducers is designed to take up less floor space than other reducers. It has a right-angle shaft arrangement which makes it possible to place the prime mover alongside the driven equipment, resulting in important savings in floor space compared with parallel or concentric shaft reducers. Hewitt-Robins Inc.

Circle 314 on Reader Service Card

Pintle chain

A new type of steel pintle chain has been developed for applications where cost, adverse operating conditions, low maintenance requirements or use with cast sprockets are the governing factors. It is formed to exceptionally close dimensions and uniform pitch from high tensile, heat-treated steel. A number of attachment links are available for use in conveying applications. Locke Steel Chain Co.

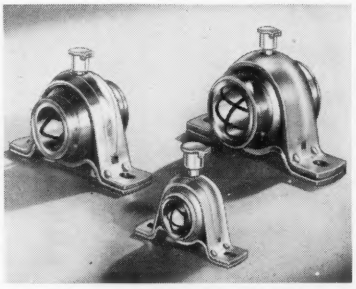
Circle 315 on Reader Service Card

Light duty pillow block

Designed for light and medium duty, a compact line of pillow block bearings has an improved lip-type seal which excludes dirt and retains lubrication more effectively. The seal efficiently maintains positive contact with the inner bearing at all times, regardless of shaft misalignment. Hoover Ball & Bearing Co.

Circle 316 on Reader Service Card

Strap-type pillow blocks



The low, modern silhouette and simplified two-bolt mounting arrangement which automatically draws the cap into proper adjustment are features of a new series of strap type pillow blocks. These compact units are designed to reduce OEM and replacement costs and are suitable for normal duty applications. Randall Graphite Bearings Inc.

Circle 317 on Reader Service Card

Flexible couplings

A line of flexible couplings is named Lo-Rez because of the low resonance or natural frequency of torsional vibration which they give to the driving and driven machines. This is accomplished by the flexible helical compression springs; the low torsional stiffness facilitates the acquisition of torsional vibration compatibility between driving and driven machines and moves the important criticals below the minimum operating rpm. Lo-Rez Vibration Control Ltd.

Circle 318 on Reader Service Card

(Continued on page 102)

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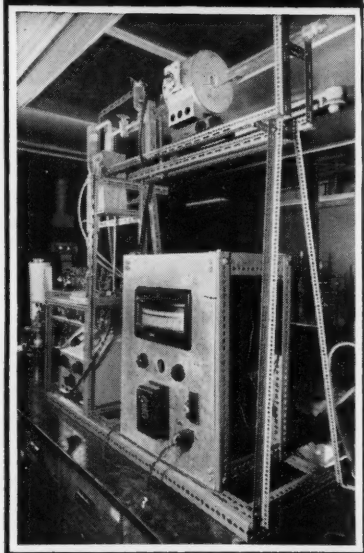

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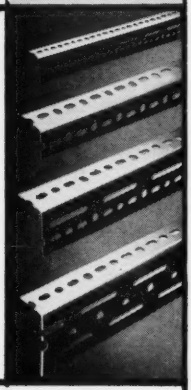

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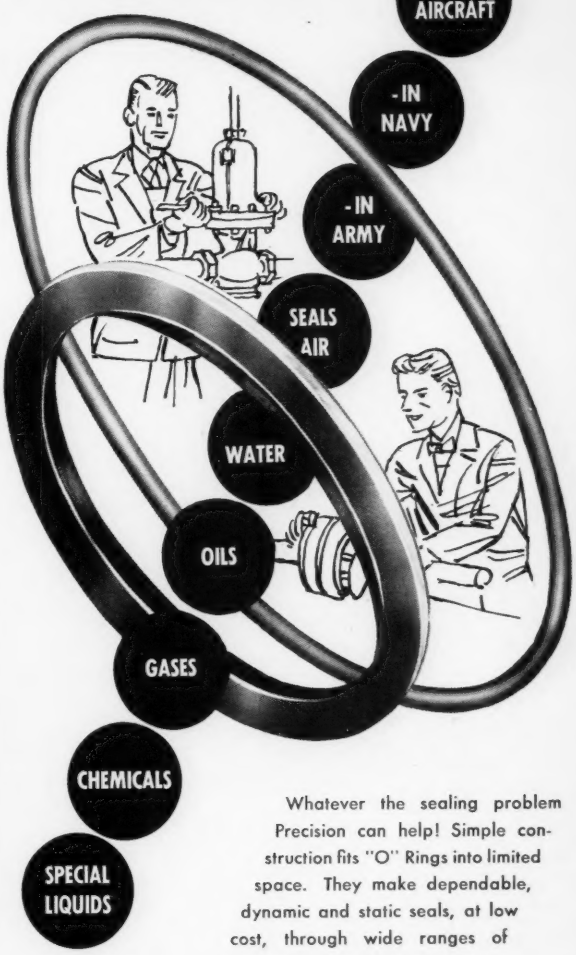

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power transmission

New/products and materials

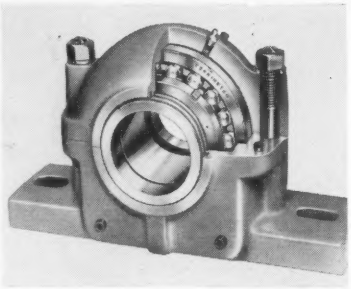
continued

Universal Joint

A new telescoping miniature universal joint allows greater freedom in the design of systems such as magnetron and klystron drives, servo drives, etc., where the precise transmission of information is essential. Two preloaded ball splines provide lateral travel and a minimum amount of thrust on connected components. Falcon Machine & Tool Co.

Circle 319 on Reader Service Card

Heavy-duty pillow block



Built for use in a wide variety of industrial applications, a new heavy-duty pillow block can be used either as a floating or a fixed unit. The roller bearings have an internal self-aligning feature that permits a reasonable latitude in alignment during installation and operation. Torrington Co.

Circle 320 on Reader Service Card

Thin bearing

For the first time an extremely thin section bearing line is available "off the shelf." It has deep-groove ball radial construction and a new one-piece bronze snap-over separator for improved bearing operation. It is used in applications where minimum bearing space and weight are desirable. Kaydon Engineering Crop.

Circle 321 on Reader Service Card

Control unit

A controlled acceleration accessory unit has been developed for 1 to 75 hp variable speed motors. The control provides a soft, smooth start to minimize any sudden starts that could damage the machine being driven or the product, especially one as delicate as paper. The control also protects equipment such as extruders where high starting torque may be detrimental to the extruding machine. To accomplish low initial torque, a reduced torque control unit is used. To suit varying load conditions and machine applications, starting torque is infinitely adjustable up to the normal rated torque of the motor. U.S Electrical Motors Inc.

Circle 322 on Reader Service Card

Swivel connector

An improved industrial swivel connector offers unique design advantages to ensure longer service life. In many instances it has eliminated the cause of hose failure due to constant flexing. It has passed exhaustive tests at 3,000 psi for one million cycles under simulated field conditions of dirt, abrasions and other foreign matter. Eastman Mfg. Co.

Circle 323 on Reader Service Card

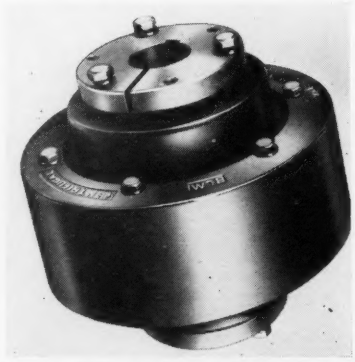
Converter unit

Developed in co-operation with transmission manufacturers, a new torque converter-mechanical transmission "package unit" consists of a single stage torque converter, standard mechanical transmission and standard mechanical spring-loaded clutch.

The unit is designed to meet the power transmission needs of vehicles engaged in frequent start-stop service or subject to wide variations in load conditions. Twin Disc Clutch Co.

Circle 324 on Reader Service Card

Clutches



A new "M" series of BLM clutches retains time proved characteristics of smooth starting and overload protection as well as automatic standby in dual drives. The series is engineered to meet custom requirements with standard stock units. It is available for use with locally stocked QD bushings and sheaves. BLM Automatic Clutch Corporation.

Circle 325 on Reader Service Card

(Continued on page 104)

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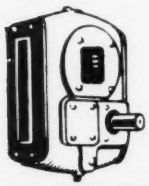
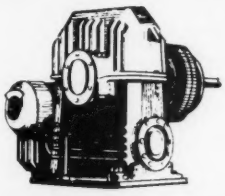
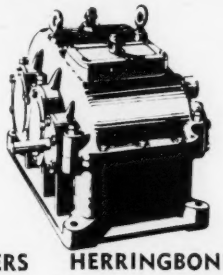
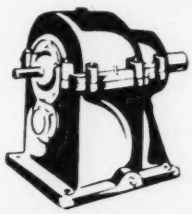
You'll be time and money ahead when you call the nearest Forano office for any and all mechanical power transmission equipment, because Forano probably has what you want in stock.



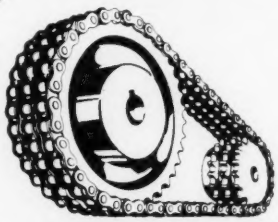


SHAFT MOUNTED & WORM GEAR REDUCERS





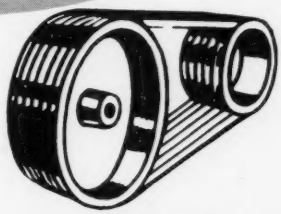
HERRINGBONE GEAR REDUCERS



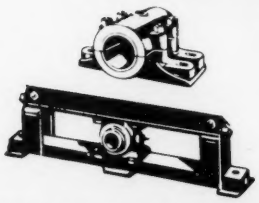
ROLLER CHAIN DRIVES

GEARING

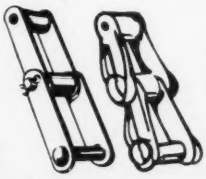
PULLEYS



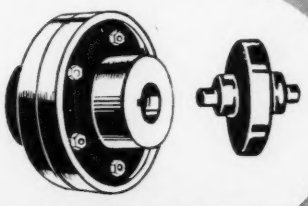
V-BELT DRIVES



PILLOW BLOCKS AND TAKE-UPS



CHAINS AND SPROCKETS



COUPLING AND CLUTCHES

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Bevel gear drive

An extra heavy duty bevel gear drive, just introduced, features a ratio of 1¾:1 and an output shaft up to 2 in. in diameter. It has been designed for use with 80 h.p. tractors and engineered for heavy power take-off machinery. It is constructed throughout of heavy duty components, including the bearings. Durst Foundry & Machine Works.

Circle 326 on Reader Service Card

Injection oiler

Designed specifically for use with low volume short stroke air cylinders, a new injection oiler provides proper lubrication previously impossible with ordinary mist-type lubricators. The oiler delivers a controlled amount of oil direct to the cylinder through a capillary tube within the cylinder air supply line. Oil is supplied to the injection oiler either from a standard lubricator placed ahead of the control valve or from a small oil reservoir under pressure. Watts Regular Co.

Circle 327 on Reader Service Card

Roller chain

A new roller chain incorporates new engineering features that provide extra durability and flexibility to meet the strenuous service demands of industrial machinery and heavy construction equipment. Extra clearance between linkplates and between pins and bushings permits up to 4 in. lateral displacement and 8 deg. twist for each 4 in. of chain to accommodate sprocket misalignment. Extra clearance also reduces stiffness after long idleness and exposure to mud and dirt. Linkplates are not bent or curved and thus transmit loads in a straight line to provide greater load capacity and withstand higher shock and peak loading. The links can be quickly installed because a drive fit is required only through one linkplate. Jeffrey Manufacturing Co. Ltd.

Circle 328 on Reader Service Card

Cushion-type couplings

A pan-shaped rubber flexing element of entirely new design is a feature of two new cushion-type couplings with high-speed, high torque and flywheel applications. They are designed to operate at higher speeds and to transmit greater torque than the standard coupling of the same family. The two types, flywheel and high speed, are similar except that the flywheel type's larger side bolts directly to the flywheel of an internal combustion engine instead of being supported by a taper-bushed steel disc. Dodge Manufacturing Corp.

Circle 329 on Reader Service Card

Ball bearing units

A line of sprocket and belt idlers is engineered as completely packaged, prelubricated and sealed units to simplify installation and provide maximum compactness and a maintenance-free life. The units are designed primarily for use as tighteners to take up slack in chain or belt drives, and can also be used as plane or direction changers. The units have a full complement of balls with case-hardened races to ensure maximum load carrying capacity. Aetna Ball & Roller Bearing Co.

Circle 330 on Reader Service Card

Pressure hose

A new nylon pressure hose is one-fifth the weight and has a wall thickness less than one-half of rubber hose with equivalent burst strength. It exhibits good resistance to flex, pressure-pulse and vibrational fatigue. It is unaffected by flammable and non-flammable hydraulic fluids, has low freon permeability and is a non-conductor of electricity. Peckover's Ltd.

Circle 331 on Reader Service Card

Speed nut

A speed nut has been designed to retain sunvisors to truck cabs. It is attached to the cab panel through two elongated mounting holes which permit a sliding lateral movement of the mounting feet during adjustment. A 5/16 in. diameter pivot rod is then inserted into the barrel of the fastener and the adjustment screw is tightened to the desired degree. Dominion Fasteners Ltd.

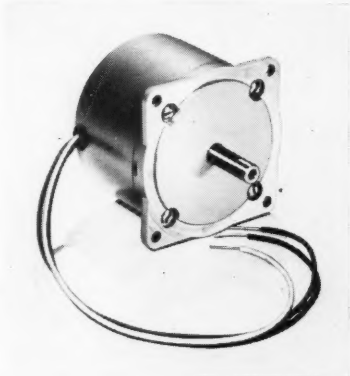
Circle 332 on Reader Service Card

Compressed air dryer

A two-stage compressed air dryer is said to offer a new approach to the problem of air removal. The first stage utilizes a helical centrifugal chamber as a pre-filter for the air stream, where water and other particle contaminants are removed, leaving only the vapor content entering the desiccant bed. The desiccant is a polychemical base in small bead form. It dissolves very slowly and needs to be added only twice a year. It is never removed or heat-treated in any way. P. J. Houston Enterprises.

Circle 333 on Reader Service Card

Synchronous motor



Especially suitable for instruments and computers, actuating selector switches, tape handling and process timing is a permanent magnet type a-c motor with constant 72 rpm synchronous speed and/or d-c stepping with instant starting, stopping or reversing. Its small size makes it particularly adaptable as an OEM component where space is limited. American Superior Electric Co. Ltd.

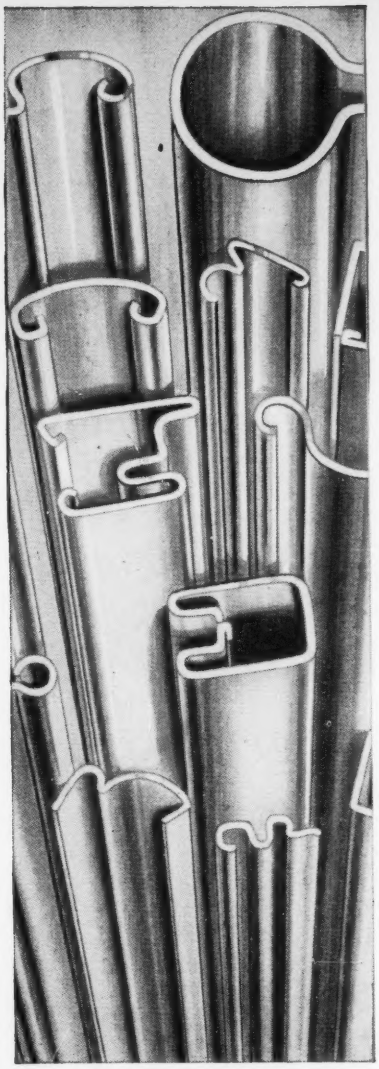
Circle 334 on Reader Service Card

Thermocouple connection-head

A small sized industrial thermocouple connection-head has been developed for high-ambient temperature and corrosive-atmosphere applications. It is the first connection-head to use an all-stainless-steel chain and non-removable screws; the screw cover cannot be dropped or mislaid. It accommodates both conventional thermocouple wire elements and metal-sheathed thermocouples. E. C. Smith Mfg. Co. Ltd.

Circle 335 on Reader Service Card

(Continued on page 105)



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For further information mark No. 122

New products

Self-adhesive polyurethane

A self-adhesive polyurethane foam in sheet form will bond itself to either porous or smooth surfaces. It can be used as cushioning, padding or packaging. The adhesive is applied to the back of the sheet of foam and is protected by an easy release paper. Morgan Adhesive Co.

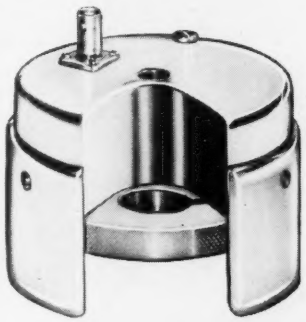
Circle 336 on Reader Service Card

Self-sticking numbers

A new self-sticking aluminum stock marker resists water, oils, alkalies and common solvents. Three inches high and made from shiny aluminum foil, the letters and numbers can be used indoors or out to identify machinery, vehicles, storage areas, etc. W. H. Brady Co. of Canada Ltd.

Circle 337 on Reader Service Card

Flow counters



Two new pre-flush flow counters have been developed for facilitating rapid geiger or proportional counting of alpha or soft beta-emitting nuclides. They differ only in size, one accepting pans up to 1 inch in diameter, while the other accepts larger sample planchets up to 2 inches. Sample pans can be changed, preflushed and counted simultaneously by means of a three-position turntable. Radionics Ltd.

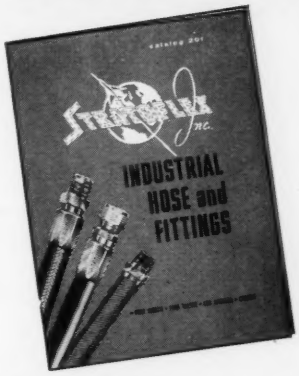
Circle 338 on Reader Service Card

Aluminum alloy

An aluminum alloy has been developed for use where intermittent high temperatures are encountered. Its uses include rail tank cars, road tankers and storage tanks, particularly for fluids which are viscuous at ambient temperatures. Aluminum Co. of Canada Ltd.

Circle 339 on Reader Service Card

Get these new STRATOFLEX catalogs now!



New Stratoflex Industrial Hose and Fittings Catalog contains 64 pages of helpful information on fluid and pneumatic lines and fittings.

New Stratoflex Fluid Power Components Catalog covers pumps, motors, valves, cylinders and power units.

SFC-A

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Address_____

For further information mark No. 173

People . . .
. . . and events

The Flintkote Co., New York, has reached an understanding with the Province of Newfoundland for the acquisition of its huge gypsum reserves. The company has immediate access to some 40 square miles of Newfoundland's gypsum producing properties at Blay Bay, and subsequent access to an area nearly 3,000 square miles in extent.

The company plans to build at least three gypsum producing plants on the Atlantic seaboard and the waterways of the St. Lawrence, from whence Newfoundland gypsum can be received, processed and sold competitively as far south as the Gulf of Mexico.

* * *

Chrysler Corporation's industrial division will market Perkins diesel engines throughout North America. F. Perkins Ltd., of Peterborough, England, was acquired last year by the Massey-Ferguson group. A recently formed company, Perkins Engine Co. Inc., of Detroit, Mich., will be responsible for the overall development of the U.S. market for Perkins engines.

* * *

Whittaker Electronics Ltd., Ottawa, has been appointed Canadian representative of Skiatron Electronics & TV Corp., New York, whose product lines include storage oscilloscopes, read-out devices, character generators and similators of various types.

* * *

J. B. Morrison Machinery Co. Ltd., Toronto, has been appointed Ontario stocking distributor for the pneumatic and hydraulic products manufactured by Modernair Corp., San Leandro, Calif.

* * *

David Brown-Foote Gears Ltd., 26 Howden Rd., Scarboro, Ont., is a new sales organization jointly owned by Foote Bros. Gear & Machine Corp., Chicago, and David Brown Corp. Ltd., London.

The new firm will handle sales of gear products made by both firms, as well as products of Whitney Chain Co., a Foote Bros. division. It will also perform manufacturing and assembly operations in its 15,000 sq. ft. plant.

* * *

Atlas Titanium Ltd. is constructing an office and research building in Welland, Ont. A metals subsidiary of Atlas Steels Ltd., it is currently engaged in developing fabricating techniques and markets for reactive metals, including titanium and zirconium.

* * *

A $2,500 scholarship has been awarded to William J. Riddell, assistant design engineer with the Saskatchewan Department of Highways. The scholarship is sponsored by Allis-Chalmers Company and made available by the International Road Federation. Mr. Riddell plans to take his master's degree in transportation engineering at Purdue University, Lafayette, Ind.

* * *

Engineering will begin immediately on a Dow Chemical Co. plant to produce polypropylene. The process will be complementary to one used by Dow at Sarnia, Ont., to produce linear polyethylene. Date of production has not yet been announced.

* * *

Executive offices and all departments of Union Carbide Canada Ltd. have been moved to Union Carbide Building, 123 Eglinton Ave. E., Toronto 12. The divisions are Bakelite Division (formerly Bakelite Co.), Chemicals and Plastics (Carbide Chemicals Co.), Linde Gases (Linde Co.), Consumer Products (National Carbon Co.) and Visking Division (Visking Co.).

* * *

Cleaver-Brooks Co., Stratford, Ont., manufacturer of packaged boilers, plans to add 10,000 sq. ft. to its plant, expanding its production facilities by 25%. The addition will permit the company to encompass the full product line of packaged boilers from 15 to 600 hp.

* * *

The National Research Council has formed an associate committee to deal with problems in automatic control. The committee will co-ordinate university, industrial and government interests in control theory and practice. It will recommend general areas for research in automatic control and will encourage research investigations.

(Continued on page 108)

Copper and Brass Association expanding

Studying the technical literature of the Canadian Copper & Brass Development Association at the recent second annual meeting are Doug Kaill (left) editor, Design Engineering; W. H. Irwin, vice-president, Canada Metal Co. Ltd.; and W. G. Deeks (right) sales division, Noranda Mines Ltd. Mr. Irwin was elected to the board in place of J. A. Taylor, president of Canada Metal. J. S. Vanderploeg, president of Anaconda American Brass Ltd., was re-elected president of the association; R. W. Summey, vice-president and general manager, Noranda Copper & Brass Ltd., was re-elected senior vice-president; and K. H. J. Clarke, manager of Canadian sales and market development, International Nickel Co. of Canada Ltd., was re-elected secretary-treasurer. The association's membership has been increased to 28 companies.

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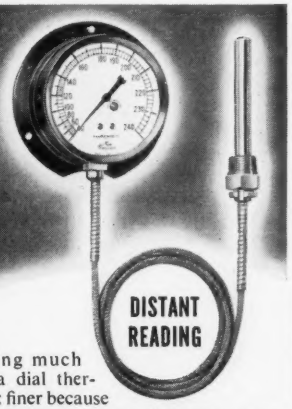

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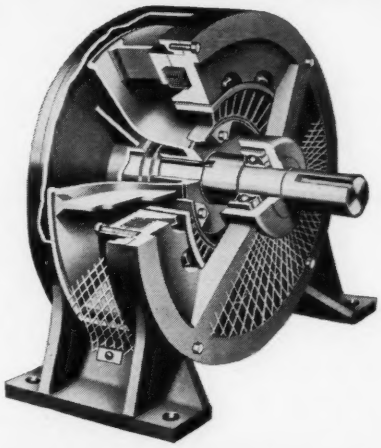

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People . . .
. . . and events *continued*

Reversing the usual trend northwards, a wholly owned Canadian company, Retor Developments Ltd., of Galt, Ont., has incorporated a U.S. subsidiary to handle sales of its Mimik hydraulic tool tracer attachments. The subsidiary, Mimik Tracers Inc., of Buffalo, N.Y., will begin as a sales and assembly operation.

The Mimik is a high precision hydraulically operated tracer which can be attached to any standard machine tool. A new development is the Templator, a simple method of preparing a template direct from the drawing, thus eliminating a previous drawback to the use of a tracer attachment.

The company has plans for expansion to Europe and Lincoln Magor, the president, will visit England this fall.

* * *

Markel Electric Products Ltd. has appointed Millen-Durnin-Parrish Ltd., Winnipeg, as its representatives to the distributor trade for the complete line of built-in and portable electric heating units. The area covered is the Prairies and Northern Ontario.

* * *

Aviation Electric Ltd., Montreal, has been appointed Eastern Canada distributor for Farinon Electric Co., whose products include radio equipment, antenna diplexers and automatic transfer for stand-by equipment.

* * *

Robert Fietsch has been named Canadian district manager for Cleaver-Brooks Co. Ltd., Stratford, Ont. He was formerly sales manager of packaged fire tube boilers for Waterloo Manufacturing Co., a Cleaver-Brooks agent since 1945.

* * *

Philip L. Carter has been appointed general sales manager of Noranda Copper & Brass Ltd. He has been with the company since it was organized in 1947.

* * *

Joseph E. Wolfe, P.Eng., has been named industrial products department representative for Sun Oil Co. Ltd.

Barry

Lang

Donald B. Barry, P.Eng., has been appointed manager of plant engineering for Dominion Engineering Works Ltd. He joined the company in 1954 as materials handling engineer.

* * *

H. J. Lang, P.Eng., has been elected president of Canada Iron Foundries Ltd. He was formerly president of National Steel Car Corp. Ltd.

* * *

Spaulding Fibre of Canada Ltd. has appointed Charles A. Dykeman general manager, Bill Christensen sales manager and B. G. Orth, assistant general manager.

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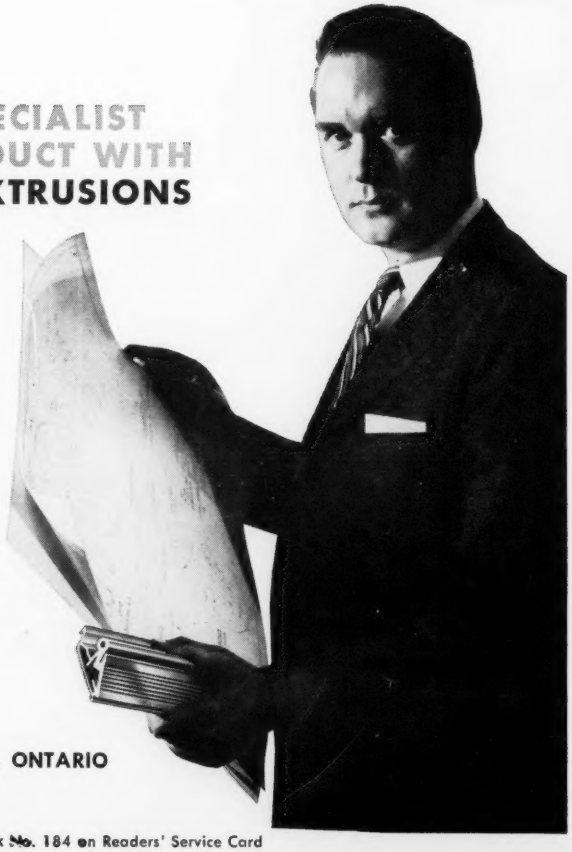

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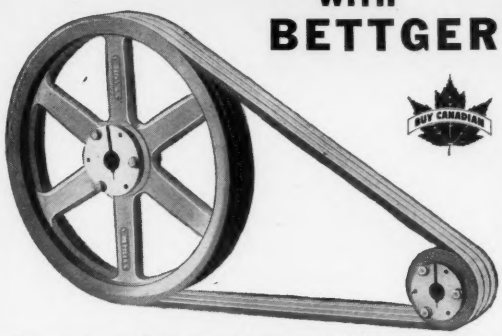
BETTER WITH BETTGER



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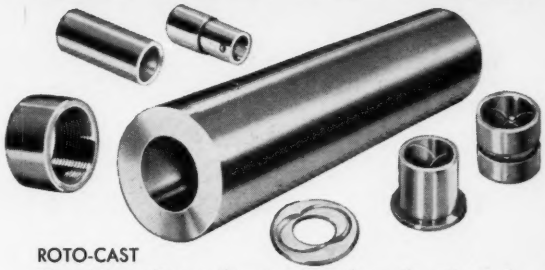

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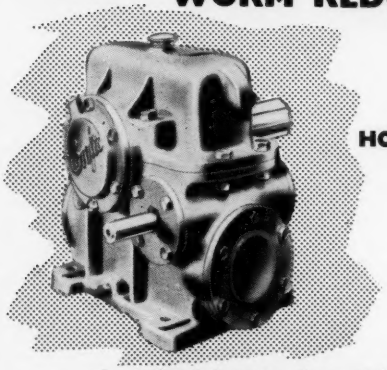

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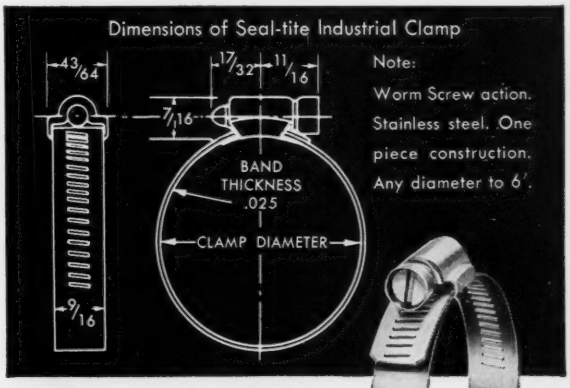

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backlash

Disturbing figures

Canada produces, pro rata, only one-quarter the patent applications of the United States. For every 1,000 citizens in our population we patent 0.1 technical inventions per annum. Across the border they patent 0.4.

The fact that we lag so far behind the U. S. will not surprise anyone. But what may cause some pain is that we are also behind all European countries of any importance, to say nothing of Japan.

Top of the list, in fact, is little Switzerland, with 1.36 inventions per 1,000 citizens. Sweden is second, though a long way behind, with 0.85 inventions. Then in quick succession come Germany, Norway, Denmark, Great Britain, the U. S., France, Holland, Japan, Belgium, Italy and Canada.

These figures come from the International Convention for the Protection of Industrial Property at Bern, which does not record patents from behind the Iron and Bamboo Curtains.

Perhaps the most dismaying thing about the figures is that Canada's per capita output of patents is down 5 per cent compared with 1930. West Germany, on the other hand, is now producing 20 per cent more patents per capita than she was 30 years ago. Nor can we take any comfort from the fact that U. S. patents during the same period declined a staggering 38%.

Reveal Red secrets

An interesting example of scientific co-operation exists between Washington and Israel. The National Science Foundation in Washington has initiated a program of translating important Russian books and articles into English. The Foundation selects the material and an Israeli body known as the Program for Scientific Translations translates it into English.

Why Israel particularly? Because Israel's position in the world of science is unique. She has provided a home for scientists from all over the world, many of them multi-lingual specialists in numerous fields of science.

The current catalogue contains headings under the following subjects among others: chemistry, electronics, fuel technology, mathematics, mechanical engineering and technology, metallurgy, physics and mechanics.

The National Science Foundation distributes the material in the U. S. Distribution for the rest of the world is in the hands of the Program for Scientific Translations, P.O. Box 7145, Jerusalem, Israel.

Fair exchange

The Russians probably don't mind, because they apparently crib our ideas in the design of consumer goods. A current best seller, The Future is Ours, Comrade (Doubleday) by Joseph Novak, quotes an engineer as saying:

"Our Soviet technology has always run along two tracks. On one track we push technical progress in nuclear energy, chemistry, applied mathematics (computers and calculators) and so forth, which are revolutionary in technique.

"On the other track we simply adapt from others. For example, in producing cameras, cars, refrigerators, radio sets, television sets and such items, we adapt items which have been tested and are considered the best in Western Europe and the United States.

"Just think," said the Russian engineer, "how much human energy is wasted in countries like the United States, where hundreds of companies, competing factories, construction firms, inventors and scientists work for the sole purpose of bringing out new models of household appliances. Out of their furious rat race of talent and creative brain power, every now and then they produce the perfect refrigerator or the ideal fountain pen. Then we take over the design and mass-produce it.

"Quite an economy for the state, isn't it? As a result, thousands of our young, able technicians, engineers and chemists go into the key revolutionary industries, which will ensure our domination of the world."

Slogans are scarce

An interesting meter slogan used by Radionics Ltd., Montreal, drew comment on this page a couple of months ago. The company's slogan is "Designed with you in mind."

Since then we've been keeping a weather eye for more postal slogans, but engineering companies seem to be rather conservative about promoting themselves in this manner. According to a rough survey we took of our morning mail, fewer than one half of 1% use meter slogans.

Here are some of the few slogans currently in use:

"Instrumentation for national defense"—Fairchild Camera & Instrument Corp., Long Island, N.Y.

"Papco, first in fasteners"—H. Paulin & Co. Ltd., Toronto.

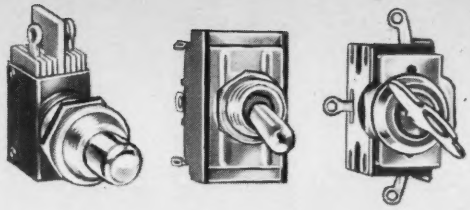
"Pioneers in the creative use of the atom"—Atomic International, Canoga Park, Calif.

Some firms, on the other hand, have excellent slogans which they use in their publicity material but not in their mail meters. A case in point is "Specialists in difficult manufacturing," inscribed on a U. S. engineering firm's literature.

Designers don't paint?

The artistic talents of John Inglis Co. employees were given expression at an art exhibition held at the company's Scarborough, Ont., works recently. Over one hundred oils and water colors painted by workers or their immediate families were hung in the cafeteria, where they were admired by hundreds of art lovers.

It was a nice idea in employee-employer relations. The only disappointing note, so far as we're concerned, is that none of the company's designers or engineers exhibited, so far as we could ascertain.



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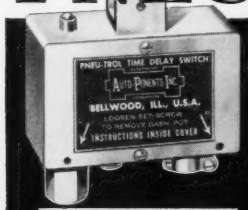
PNEU-TROL



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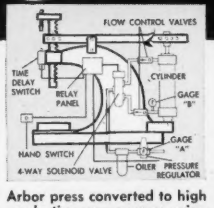
FOR CONTROLLED TIME DWELL OF AIR OR HYDRAULIC CYLINDERS



Arbor press converted to high production power press, using double end cylinder, Time Delay Switch, Flow Control Valves, and related equipment. Flow Valves permit independent ram speed adjustment in both directions. Differential pressure between "A" and "B" gages caused by throttling effect of Flow Control Valve creates time interval in working pressure build-up, which is compensated for by Time Delay Switch setting. This insures consistently accurate working pressure on the ram.

- **Holds dwell accurately to fraction of second**
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- **Designed for millions of actuations**

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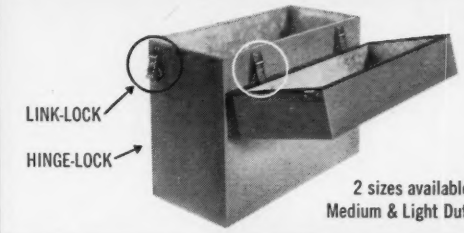

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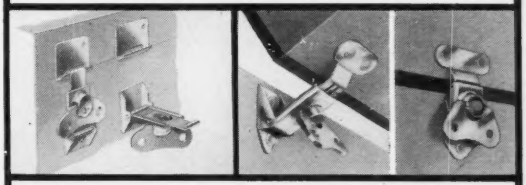

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Editorial

A word about employee engineers . . .

. . . and other important items of interest to all professionals

The professional engineers of Canada are heading for a significant period of decision making. We expect to see some major changes in the organization and management of the provincial associations come out of the prevailing unrest. This unrest has been precipitated—in the main—by the growing discontent among those engineers who choose to classify themselves as "employee engineers."

At the present time the movement centres around the Associations in Quebec and Ontario, but there are signs it is spreading. The current issue of the 'B. C. Professional Engineer,' for instance, carries an article under the byline of Dr. H. L. Keenlyside on the subject of "The Registration of Employee Engineers." In any case, the number of engineers in Quebec and Ontario represents the majority in Canada, and any moves they make are sure to have their effect on the whole profession.

According to the literature reaching our desk the one big decision to be made — albeit indirectly — is whether the ruling councils, being composed almost entirely of men of the management level, adequately represent and speak for the 'little man' in engineering. There are many who feel the councils as presently constituted do not.

What can be done about it?

In Quebec toward the end of 1959 a Committee for the Advancement of the Employee Engineer was formed among the professional engineers of that province. This committee sponsored contestants for two of the council positions in the 1960 annual elections, and both were elected with good majorities.

At the annual meeting we attended early this year, the same Committee sponsored a motion on behalf of a permanent committee within the association to deal with employee problems. So much to the good. Now we are advised that the same Committee in Quebec are talking about "taking over" the council next year. We sincerely trust that they reflect at length upon the importance of such a move. Enthusiasm is rarely a satisfactory substitute for experience. A combination of both is more to be desired.

In Ontario also there has recently been organized a Committee for the Advancement of the Professional Engineer (CAPE). Note that although there is no mention of the 'employee' engineer in the name of this committee, their aims and activities would indicate that it should have been included. No doubt it was omitted on purpose. Objectives have been set forth for this Ontario Committee as follows:

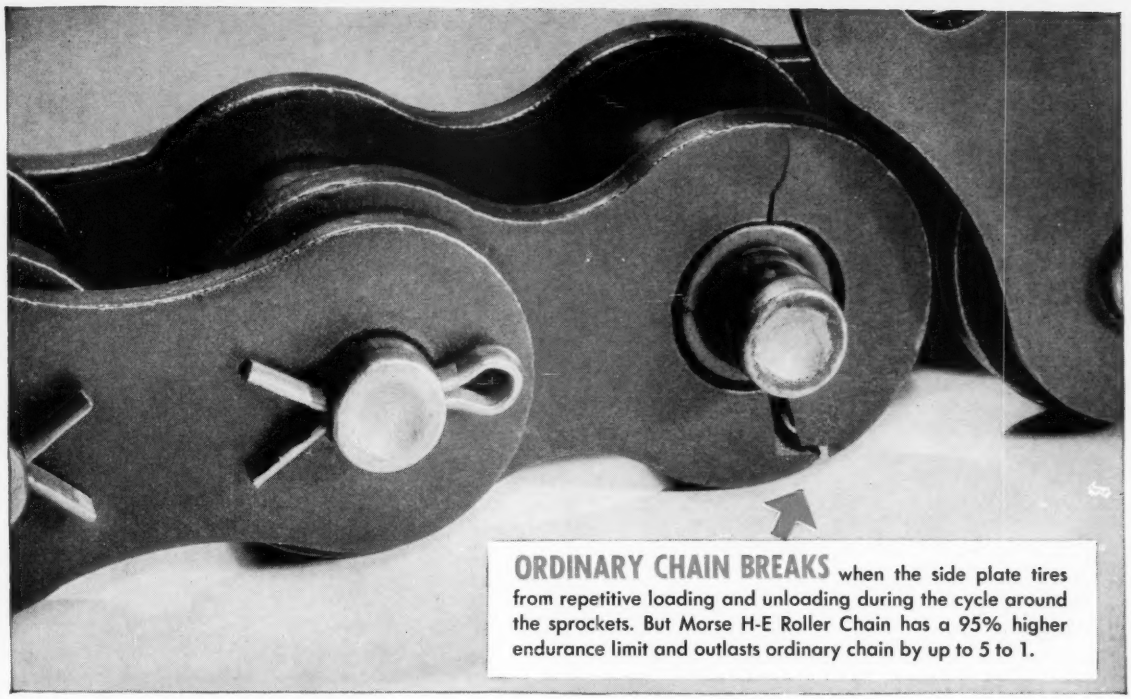
1. To create an environment within the APEO in which individual engineers or groups of engineers can act effectively on their own behalf in matters relating to professional authority, status and remuneration.
2. To establish a system of communication to obtain and publish the views of members of the APEO, paying particular attention to ensure a voice for employee professional engineers.
3. By such communication to stimulate and collect the ideas of professional engineers on the present APEO organization and policy.
4. Finally, to gain approval of APEO members for any reforms necessary to ensure the responsible representation of the profession, and to provide the utmost in public protection and advancement of the profession.

We agree with all four of these objectives—to do otherwise would be to betray our trust as a professional. *After all, these objectives are included in the objectives of the ten provincial associations.*

In Ontario there is also talk of running a full slate of candidates for the council under the CAPE banner in the next annual election. If a few are elected it could be a good step—but our words of caution given above to our Quebec associates apply equally as well in Ontario.

One final thought. This term "employee engineer" has always been an enigma to us. In an effort to find out what our fellow engineers understood by the term (and to introduce our new feature 'OPINION POLL') we quizzed a number of p. engs. Most of those queried had no opinion—a condition we find hard to understand. Those answers received (see page xx) indicate that there is now no one meaning—but if the term is to continue in use it is imperative that a single definition be found. The pages of DE are open for further discussion on the subject.

Doug Kaill



ORDINARY CHAIN BREAKS when the side plate tires from repetitive loading and unloading during the cycle around the sprockets. But Morse H-E Roller Chain has a 95% higher endurance limit and outlasts ordinary chain by up to 5 to 1.

"Tired Metal"... the bane of chain now licked by MORSE H-E

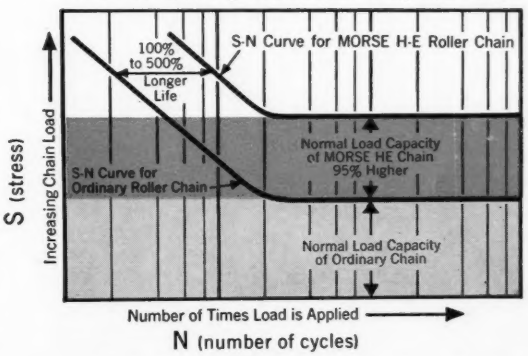
Morse H-E Roller Chain has up to 500% longer service life . . . cuts replacement and labor costs

The unretouched photograph shows what happens to chain when the metal fatigues. But now a special Morse process has licked the "tired metal" problem. It gives Morse H-E Roller Chain 95% higher endurance limit . . . and up to 500% longer service life.

The special process means Morse H-E Chain costs about 10% more. But that's a small price to pay for a heavy-duty chain that can save you thousands of dollars annually in replacement costs, downtime, and wasted man-hours.

For more information on the chain that licked the "tired metal" problem once and for all, see your local Morse Distributor. You'll find him listed in the Classified Directory under "Power Transmission." Or write: Morse Chain of Canada, Ltd.—a Borg-Warner Industry—Simcoe, Ontario. Phone GArfield 6-4960.

Chain Life: Morse High Endurance vs. Ordinary Roller Chain


100% to 500% Longer Life
S-N Curve for MORSE H-E Roller Chain
Normal Load Capacity of MORSE HE Chain 95% Higher
S-N Curve for Ordinary Roller Chain
Normal Load Capacity of Ordinary Chain
S (stress) Increasing Chain Load
Number of Times Load is Applied
N (number of cycles)

Red area: Under these chain loads, fatigue will break ordinary chain . . . but *not* Morse H-E.

White area: Under these loads, fatigue will break ordinary chain and Morse H-E . . . but Morse H-E will have operated 100% to 500% longer.

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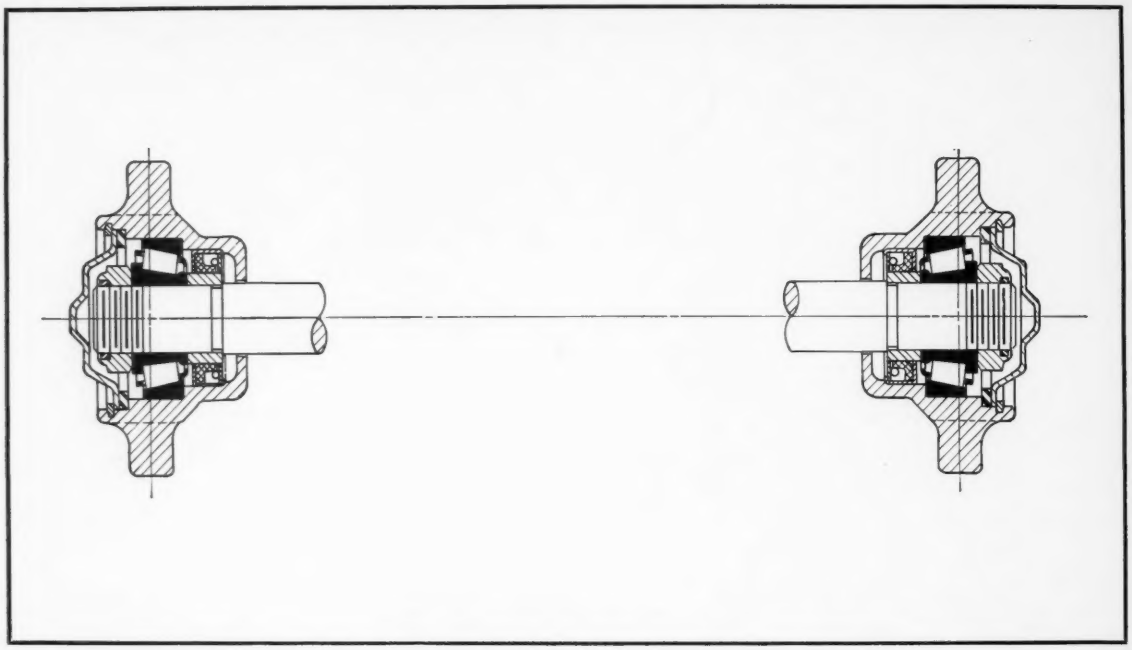
For further information mark No. 151 on Readers' Service Card

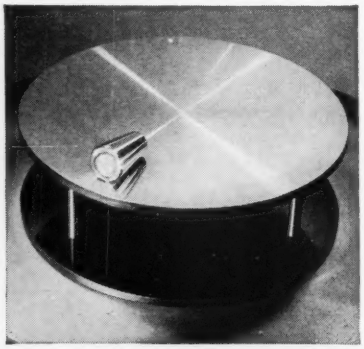
HOW JOY MOUNTS IDLERS TO FIGHT WEAR FROM DIRT AND DUST



By designing their Limberoller® two-bearing, single-unit catenary idlers to use Timken single-row tapered roller bearings (see above), Joy Manufacturing engineers reduce bearing failures caused by dirt, dust, moisture . . . assure spillage-free conveying and trouble-free idler performance. Timken bearings hold the idlers on center at all times, increase sealing efficiency. Idlers roll easily under heaviest loads, belt moves smoothly.

On these applications, Timken bearings assure minimum maintenance, long bearing life because: 1) They hold shafts concentric with housings, making closures more effective in keeping lubricant *in*, dirt *out*. 2) The tapered construction of Timken bearings lets them take radial and thrust loads in any combination.

ENGINEERING SERVICE FOR THE ASKING. Let our Timken bearing salesmen—graduate engineers—tackle your bearing problems, solve them in a hurry. Save *you*—time and money.



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